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DAMSITE, SOUTH YUBA HYDRO-ELECTRIC POWER PROJECT, PACIFIC GAS & ELECTRIC COMPANY.

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EDITORIAL

MISPLACED decimal points are a frequent source of trouble. Mr. C. F. Braun's article on 'Filters at Presidio Military Reservation, San Francisco,' in the October issue, states that one-half grain of alum is used per 1000 gallons. This amount should have been stated as one-half grain of alum per gallon, the figures otherwise being correct.

CHIEF contributing factor to the fame of Milwaukee has proved singularly impotent in the newly formed Celestial Republic, as is shown by the failure of a $500,000 corporation which until recently was engaged in the manufacture of beer at Hongkong, China. The Chinese seem to prefer their own peculiar brands of tipple, and perhaps looked askance at the possibility of permitting anything distinctly German in its origin to settle in their interior.

AN interesting by-product of modern internal-combustion engine practice is the utilization of the heat in the exhaust gases for generating steam for operating small steam auxiliaries, and for furnishing hot water for various purposes. As the exhaust gases contain more or less sulphur and other corrosive agents, fear has been expressed that the destruction of boiler tubes would more than counterbalance the benefit derived from utilizing the heat of the waste gases. Experiments looking toward the development of a special corrosion-resisting metal now under way have shown that soft steel alloyed with about 40 per cent of copper has a maximum resistance to acid corrosion. The solubility of this copper-steel in 20 per cent sulphuric acid is about 1 per cent of the solubility of the same steel without copper, although under dilute acid conditions the difference in solubility is not nearly so great. Service tests of this new alloy are now in progress, and the prompt response of American manufacturers to the new demand is further recognition of the fact that the internal-combustion engine has come to stay.

APROPOS of the present shortage in the supply of gasoline, Bulletin 43 of the Bureau of Mines gives some interesting data concerning denatured alcohol as a possible substitute. As a result of over 2000 tests conducted at the Government testing plants, it was found that, notwithstanding the low heating value of denatured alcohol, 10,500 British thermal units per pound as compared to 19,200 for gasoline, a gasoline engine having a compression presure of 70 pounds, but otherwise as well suited to the economical use of denatured alcohol, will, when using alcohol, have an available horse-power about 10 per cent greater than when using gasoline. The relative compression pressure that can be used without causing pre-ignition is about 2½ times greater for denatured alcohol than for gasoline, while the maximum pressure was found in each case to produce the best results with regard to fuel economy. While gasoline requires twice the amount of air for complete combustion that is required by denatured alcohol, the heating value of one cubic foot of an ex-

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plosive mixture of alcohol vapor and air is approximately equal to one cubic foot of a similar mixture of gasoline vapor and air. It is generally claimed that unlimited quantities of denatured alcohol can be obtained in all parts of the world at comparatively low cost, and although it is well understood that some types of gasoline engines are better adapted for the service for which they are intended than alcohol engines, there is an undoubtedly promising field for the development of an increased use of denatured alcohol for power purposes. Now that gasoline users are becoming restive under the pinch of high prices, the alcohol-driven automobile may not be far distant.

The Oil Situation

Oil men in California have been much interested in negotiations for a change in control of the Union Oil Company. It has been variously announced that this concern had been sold to the Standard Oil Company, the Shell Trading & Transportation Company, and the General Petroleum Company. Knowing that the Shell and Royal Dutch interests were expanding their holdings, it was at first accepted that the ownership of the Union Oil Company had passed to them. At the same time the Standard Oil Company published an official denial of the report that it had purchased the company. It was finally announced on November 17 that the real purchaser was the General Petroleum Company, which is controlled by Messrs. Eugene De Sabla, John Barneson, W. P. Hammon, and their associates. By this purchase the General Petroleum Company adds to its own holdings in the Santa Maria, Midway, Coalinga, Fullerton, Sunset, Belridge, and Lost Hills districts 152 producing oil wells, 11 tank steamers, 4 tank barges, a tug, and 681½ miles of pipe-line, besides the ownership of 26,250 acres of the mineral rights on 132,250 acres, oil leases controlling 56,189 acres, and 16,801 acres covered by mineral locations; also refineries and a well-established selling agency. The Union Oil Company is a California concern capitalized for $50,000,000 and controlled by the Stewart family, whose holdings are the ones transferred by this deal. It has been well managed and has been paying 6% dividends. The General Petroleum Company is a newer concern with extensive land holdings, but without, as yet, a large production. It is now engaged in building pipe-lines and other surface equipment, and is evidently to be an important factor in the oil market. A short time ago it purchased the Continental Petroleum Company, which owns 160 acres in the Midway field, 520 at Coalinga, and 5500 in the Mexican oilfields. The Continental was organized by Mr. William Graham, of California, and is the company in which Mr. A. Chester Beatty and Mr. H. C. Hoover are heavily interested. Since it is understood that they and their associates have gone into the General Petroleum Company, the latter has secured by the deal not only land but backing. The money for purchase of the Stewart holdings in the Union Oil Company is said to have come mainly from New York. Since the Independent Producers' Association is in close and friendly alliance with the Union, it is presumed that oil from this concern will also fall to the General Petroleum Company. Whether the Associated will go along with the crowd and thus present a united front to the Standard Oil Company, remains to be seen. Certain it is, however, that the ability of the

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Standard Company to take care of itself as manifested in the past is no less existent today. It will be most interesting to see whether the oil situation will resolve itself into a titanic struggle for supremacy, or the consummation of a gentleman's agreement looking toward a division of the business and profits.

Selling Professional Services

Success is the goal of all endeavor. The world may owe every man a living, but only a patient and persistent collector can make the world stand and deliver. Professional and commercial men differ in their relationship to those whom they serve, but both aim to accomplish the same object, namely, to achieve success, meaning, in the eyes of the world, to make money. It is of small moment whether one is striving to sell professional services or merchandise, the entire question resolves itself into selling what one has for sale, at a price that will bring the utmost possible profit. In considering the question of successful selling from the standpoint of the engineer, useful lessons may be learned from the methods employed in commercial pursuits. The evolution of industrial life has emphasized the prime necessity of publicity, advertising, salesmanship, scientific management, and countless other things that have been potent contributing factors to the wonderful industrial development of the United States. This development has gone on many years, and the commercial man has been growing richer and richer, but what is the financial status of the professional engineer today? The answer is not difficult. Many engineers are employed in commercial pursuits that bear no relation to their technical training. Some have salaried positions with large utility corporations and engineering concerns, but most of them, unfortunately, must be content with mere 'jobs' at rates of pay about equal to those of ordinary clerks. The consulting engineer, formerly a haughty dignitary to whom the layman came for engineering advice and to whom he paid a consulting fee without question, is almost obsolete. The manufacturer of machinery and the engineering contractor have been encroaching more and more upon what has heretofore been considered the engineers' special field and are making it a practice to furnish free information and advice in the hope of ultimately obtaining an order for machinery. The consulting engineer today, with a few notable exceptions, finds his busy hours growing fewer and fewer, with an increasing disposition on the part of his clients to haggle over fees. A remedy for this condition is easy to suggest, but difficult to put into practice. The custom among manufacturers of giving away all sorts of information aside from details regarding their own apparatus has been growing until it has reached a point where a prospective customer in the market for machinery feels slighted if the manufacturer will not send an engineer to design his plant, report on his project, and furnish without charge a complete set of working plans and specifications. This is unfair to the manufacturer as well as to the practising engineer, and gives to the prospective buyer something for nothing, for which he could and should pay a reasonable fee. Not only that, but shrewd and experienced buyers, by playing upon the anxiety of competing manufacturers to make a sale, often get half a dozen or more sets of plans submitted, of which only one may be accepted, the others repre-

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senting a dead loss of time and money. Manufacturers naturally cover this expense in calculating the overhead burden added to manufacturing costs, and in the end the consumer, as usual, pays. If, however, this practice were abolished, manufacturing costs could be proportionately lessened, the buyer would have to retain an engineer and pay him for his professional services, and all three parties to the transaction would be benefited. As to the engineers' side of the question, while we have no disposition to scold, we venture to express the opinion that if a little of what Mr. Montague Glass would call a 'First-class A-No. 1 salesman' were included in his makeup, he would be better off. Engineers are prone to sit in their offices waiting for the mountain to come to Mahomet. Dignified yet effective solicitation need not transgress the ethics of the profession. Every manufacturing establishment has a sales manager, a big, two-fisted, cold-blooded individual who emanates great quantities of dynamic force and prods the men under his supervision to never-ending effort, and who recognizes but one thing: results. Practising engineers might train some sixth sense to perform the function of sales manager, to make them miserable if they come home at night without clients, and yet spur them on toward renewed efforts when the next day begins. Advertising is a word that grates harshly on professional ears, and yet without it the progress of the world would be greatly impeded if not halted altogether. To be effective, advertising must be in keeping with the character of the thing offered for sale, and there is a form of advertising for engineers that is as proper as is the brass band and three-sheet poster for a circus. The correct and at the same time most effective publicity is based upon frank interchange with fellow-workers of professional data. Here more than all other places is it true that the one who gives, receives in return rich benefits. Modesty is a jewel beyond compare, and yet to shrink from disclosing to other engineers the details, procedure, methods, and lessons learned during the course of engineering work is not only foolish but harmful. Publicity helps the engineer who does the work, the engineer who may have similar work to do, and benefits all through the dissemination of knowledge.

RECENT ruling of the California Railroad Commission requiring the Southern Pacific Company to file a train schedule showing all stops and non-stops of limited trains, has brought about a question that may put an end to limited-train service in California. The town of Ventura has complained that the Shore Line Limited does not stop at that point, and if the Commission should grant their petition, the way would be open for other towns along the line to make similar demands and thus put all limited train service at an end as far as California is concerned. To grant Ventura's request would place railroad passenger service back where it was twenty years ago and greatly retard the development of the state. The town of Ventura is entitled to as good service as its size and commercial activities would justify. If discrimination has been made against Ventura as compared to other towns of relatively the same size, it is another story, but we hope that the way may not be thrown open for the granting of requests of this kind in order that a few possibly may benefit at the expense of many.

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REVIEW OF THE MONTH

ELECTION is over. The 'rights of the people', the 'palladium of our liberties', and kindred pre-election paraphernalia have been neatly packed away in the cedar chest, where they may repose in safety until all good men and true are again called upon to come to the rescue of their country. The events of November 5 seem scarcely to have created a ripple on the surface of business. All sorts and conditions of men are united in expressing their satisfaction at the outcome, and predict the approach of an unparalleled era of prosperity.

PRESIDENT-ELECT WILSON has announced his intention of calling an extra session of Congress on or about April 15, 1913, in order to proceed at once to carry out the party's pledge toward a downward revision of the tariff. It is believed that reasonably quick action may be expected, as such a mass of information was collected by the late lamented Republican Congress four years ago that it is likely that the testimony used as an excuse for increasing duties, may serve the Democrats equally well as a reason for reducing them. The old cry that juggling with the tariff would ruin business is effectually disposed of by the increased activity on all sides.

SOUTH YUBA and Bear river hydroelectric power development for the Pacific Gas & Electric Company will add 40,000 kilowatts to the company's generating capacity. The frontispiece for this month shows the Yuba river damsite, where a concrete dam 300 feet high, of gravity-type section, arched upstream, will impound 4,000,000,000 cubic feet of water. The natural rock buttresses are clearly shown in the illustration, all engineering conditions being exceptionally favorable to this enterprise. Electric power will be transmitted at 115,000 volts on a double circuit tower line via Nicolaus to Cordelia. At this point the voltage will be reduced to 60,000, at which it will be transmitted to the consumer over the various parts of the distributing system.

RAPID progress has been made on the building of the Panama canal, according to the report of Colonel Goethals for the year ended June 30, 1912. The exaggerated idea of the importance of the slides that have taken place periodically in the Culebra cut is dispelled by the report of Mr. Donald F. MacDonald, geologist, which states that: "Thus far increase in the estimates of material to be removed made necessary by the slides, will cause no increase in the total estimated cost of Culebra cut, as the division costs were reduced during the past year, effected in part by increased efficiency of the organization, by the fewer interruptions in the transportation service, by slides and water, by the better conditions generally of the dumps, and by the upkeep of the output, due to the amount removed by the shovels on the upper reaches." The average Central-division cost of excavation for the year, including plant charges and all items which entered into its accomplishment, was $0.5101 per cubic yard.

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The quantity of material excavated for the year reached an astonishing total, including 634,747 cubic yards for the Pacific division alone, at a cost of $0.6566 per cubic yard. Concrete placed in the pit for the Miraflores locks aggregated 751,540 cubic yards, of which 729,096 cubic yards was plain and 22,444 cubic yards was reinforced. The total amount of masonry laid in the locks on the Pacific side was 935,410 cubic yards, and 174 cubic yards in the wing walls, at an average cost per yard of $4.5867 for plain concrete and $10.6388 for reinforced. There remains to complete the locks on the Pacific division 51,150 cubic yards at Pedro Miguel and 386,729 cubic yards at Miraflores, while the cut-off walls at Pedro Miguel still lack 3000 cubic yards and the Miraflores dam 75,000 cubic yards. The plans provide for a dry-dock capable of accommodating any vessel that can pass through the canal locks. It will have a usable length of 1000 feet, an entrance width of 110 feet, and a depth over the keel blocks of 35 feet at mean sea-level. The dock will be built in the rock, which will be lined with concrete after it has been excavated. The borings indicate that the rock is strong, solid, and well suited for such construction. In lieu of the marine railway at first contemplated for smaller classes of vessels, an auxiliary dry-dock will be provided, for which a similar foundation on suitable rock has ben found. This dock will have a usable length of 350 feet, a width at entrance of 71 feet, and a depth over the keel blocks of 13½ feet at mean tide. On the Atlantic side, the present dry-dock at Cristobal, which has a usable length of 300 feet and a width at the entrance of 50 feet, with a depth over the sill of 13 feet at a mean sea-level, will be retained.

PROCLAMATION was signed by the President on November 13 fixing the rates to be paid by foreign shipping for passage through the canal. A merchant vessel rate of $1.20 per net ton in actual carrying capacity is established with a reduction of 40 per cent for ships in ballast. The proclamation provides as follows: First—On merchant vessels carrying passengers or cargo, $1.20 per net vessel ton, each 100 cubic feet, of actual earning capacity. Second—On vessels in ballast without pasengers or cargo, 40 per cent less than the rate of tolls for vessels with passengers or cargo. Third—Upon naval vessels, other than transports, colliers, hospital ships, and supply ships, 50 cents per displacement ton. Fourth—Upon army and navy transports, colliers, hospital ships, and supply ships, $1.20 per net ton, the vessels to be measured by the same rules as are employed in determining the net tonnage of merchant vessels. The Secretary of War will prepare and prescribe such rules for the measurement of vessels and such regulations as may be necessary and proper to carry this proclamation into full force and effect. No reference is made in the proclamation to Great Britain's protest at the exemption of American coast-wise vessels from the payment of tolls.

REPORT of Mr. Emory Johnson, upon which the President based his declaration, has also been made public. According to the report, the canal should be upon a self-supporting basis within twenty years. It should compete successfully with the Suez route for the traffic of Europe with South America, west coast ports, and with New Zealand, but cannot hope to successfully compete for Europe's trade with the Far East. Taking into con-

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sideration the estimates of the Canal Commission for expenses of operation and maintenance and for improvements that will probably be necessary at the end of the first ten years of operation, it is estimated that at the end of this time the rate can be reduced to $1 per net ton. At this rate the United States will obtain enough revenue from foreign vessels to pay all fixed charges, provide a sinking fund of 1 per cent to retire Panama canal bonds, and still find a yearly balance. The report shows that a foreign traffic of about 9,000,000 tons may be expected through the canal during the first two years of operation, a traffic of more than 11,000,000 tons in 1920, and 14,000,000 tons in 1925. With reference to the rate on war vessels of 50 cents per ton, Mr. Johnson says: "The tolls upon merchant vessels should be fixed low enough to enable the Panama canal effectively to promote the commerce of the United States, but the Government is not called upon to make the Panama canal tolls upon warships low for the purpose of lightening the naval burdens for foreign countries in sending their warships through the Panama canal. Foreign nations should pay tolls high enough to cover costs and risks incurred by the canal authorities in performing the service rendered."

FREE tolls for American coastwise vessels are subject to criticism, Mr. Johnson expressing his opinion that those who believe that such action will benefit American shipping are placing their subsidy in the wrong place. The report says. "Our shipping employed in the foreign trade needs assistance, but our coastwise marine has a monopoly of the coastwise trade and does not need further aid. In 1911 there were 3,537,750 tons of American ships enrolled for the domestic trade on the Atlantic, Gulf, and Pacific seaboards. The increase during the preceding decade has been 38 per cent. There is thus a relatively large and healthy increasing tonnage of coastwise shipping; and the opening of the Panama canal will undoubtedly bring about a large addition to the coastwise fleet. Our coastwise marine is now given sufficient aid and protection by our navigation laws." The question as to whether the Hay-Pauncefote treaty has or has not been violated is not discussed, as being without the province of the investigator. Mr. Johnson, however, in discussing whether the canal should be made commercially self-supporting, says: "The Panama canal should be made commercially self-supporting. Tolls based upon the value of the service rendered by the canal are justifiable. Those who use the waterway may justly be required to make some compensation for the benefits received. Tolls not unduly restricting the commercial usefulness of the waterway may be levied that will yield revenue enough to meet operation, maintenance, sanitation, government, annuity, and interest charges. The same rate of toll should be charged upon American as upon foreign vessels."

ANY feeling of resentment that may exist in the minds of our British cousins across the water over the alleged violation of the Hay-Pauncefote treaty has not thus far been reflected by a cessation of activity toward preparing for the opening of the canal. European shipyards are working at high pressure, and are likely to do so for some time to come. The Pacific Steam Navigation Company, which operates a large fleet of vessels along the west coast of South America, has placed

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a contract for five new vessels with a Belfast shipyard. On November 1 the Hamburg-American company had no fewer than 19 large steamers under construction, including three 50,000-ton vessels of the *Imperator* class. A 19,000-ton vessel is being built at the Vulcan yard for the Panama service and two 18,000-ton steamers for the La Plata service. Other vessels of minor importance will bring up the total tonnage under construction for the Hamburg-American company to 270,000 tons gross. The North German Lloyd company has placed orders for 11 steamers totaling nearly 110,000 tons, and others are under construction. The Hamburg-South American line has four steamers aggregating 66,000 tons, and others building. The German Australian company has five steamers under construction of 5000 tons each, five of 9500 tons each, and five of 12,000 tons each, nearly all of which are being built in German yards. Americans had better be up and doing, lest the fruits of their wonderful engineering achievement be taken from them.

ANNOUNCEMENT has been made that within a few days the United States Government will commence suit against the Southern Pacific Company for the recovery of approximately 60,000 acres of oil land situated in the Coalinga district. The lands involved were granted to the Southern Pacific Company by an act of Congress under date of July 27, 1866, for the purpose of aiding the construction of a railroad southeasterly from San Francisco to connect with another section of the company's line between California and Arizona near Needles. The tract which is the basis of the suit is covered by United States Patent No. 22, of July 10, 1894, which transferred to the Southern Pacific Company 440,000 acres of land. The contention of the Government in this suit, as well as in others already commenced against the railroad company, is that in administering their grants the question of the mineral character of the lands was never investigated or adjudicated, and that when patent was granted to the company it expressly excepted all the lands that were mineral in character. The acceptance by the railroad company of such title would indicate its acquiescence in the provisions of the patent as a correct definition of the title, and the company, by such acceptance, would therefore be estopped from denying the validity of the exception inserted in the patents. The Southern Pacific Company, on the other hand, contends that it was the duty of the Interior Department to determine whether the lands were mineral before issuing patent, and that the Government could not shirk this duty by inserting into the patent an exception of mineral lands, therefore the issuance of a patent is an adjudication binding upon the Government and that the lands patented are not mineral. The question now is whether the patent shall be construed as a conclusive adjudication by the United States, acting through the Interior Department, that the lands patented are not mineral. Opposed to this is the Government's contention that the railroad company, having accepted the patents containing the mineral exceptions, are now estopped from denying the validity of such mineral exceptions. It is stated that the land in question has been undergoing investigation by a corps of experts for some six months, and that they have determined that all of the land is mineral. The value of the lands involved is estimated at over $300,000,000.

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Mission Viaduct

By C. M. TAYLOR*

GOOD ROADS, convenient grades, and problems of handling traffic of all kinds are subjects which require constant attention. To meet these conditions, a permanent and economical solution is a matter of great importance to every community, especially in large cities where in some sections one roadway must accommodate street railroads, automobiles, carriages, and other conveyances, and commercial vehicles of all descriptions. After the authorization of the required funds, the municipal engineering department has not only to meet the engineering phases of the problem, but must make the best possible use of the funds allotted to each separate portion requiring improvement. The various municipal betterments in San Francisco have been carried out in the most creditable manner by the city engineering department.

About four miles south of San Francisco's civic centre, Islais creek winds its way to tidewater and crosses Mission street far below the elevation necessary to accommodate the varied and enormous traffic over this section of the city. In early days traffic had to go to the bottom of this ravine. Later the Ocean Shore railroad took advantage of this ravine as pass to the valleys on the coast side, and the grade of Mission street was raised by a wooden trestle giving an overhead crossing above the Ocean Shore tracks. This, however, was soon found to be inadequate, and expensive to maintain.

The final solution was found in the construction of a reinforced-concrete viaduct to span the ravine and give permanent relief to the long existing troublesome traffic conditions at this point. The general outline of the plans called for a viaduct 906 ft. long, the greater part of which consisted of two side-walls tied together by tie walls spaced 24-ft. centres, making compartments 58½ ft. long and 23 ft. wide, and varying in depth from 15 to 32 ft.; an overhanging sidewalk 12 ft. wide, with a protective handrail 3½ ft. high at its outer side; an earth-filled approach at both north and south ends; and two overhead crossings, one of 60-ft. span for Springdale street and the other of 137-ft. span to accommodate four railroad tracks.

Before construction on the viaduct proper began, it was necessary to construct and maintain a temporary trestle to accommodate two railroad tracks and all traffic during the period of construction of the viaduct. This temporary structure extended to a length of 1000 ft., supported by pile and framed bents, and towered 35 ft. above the original ground surface. This provided a roadway 25 ft. in width and a 3-ft. sidewalk for pedestrians. The footing grades of the new structure follow the general contour of the land, but the design necessitated the excava-

*Assistant City Engineer, San Francisco.

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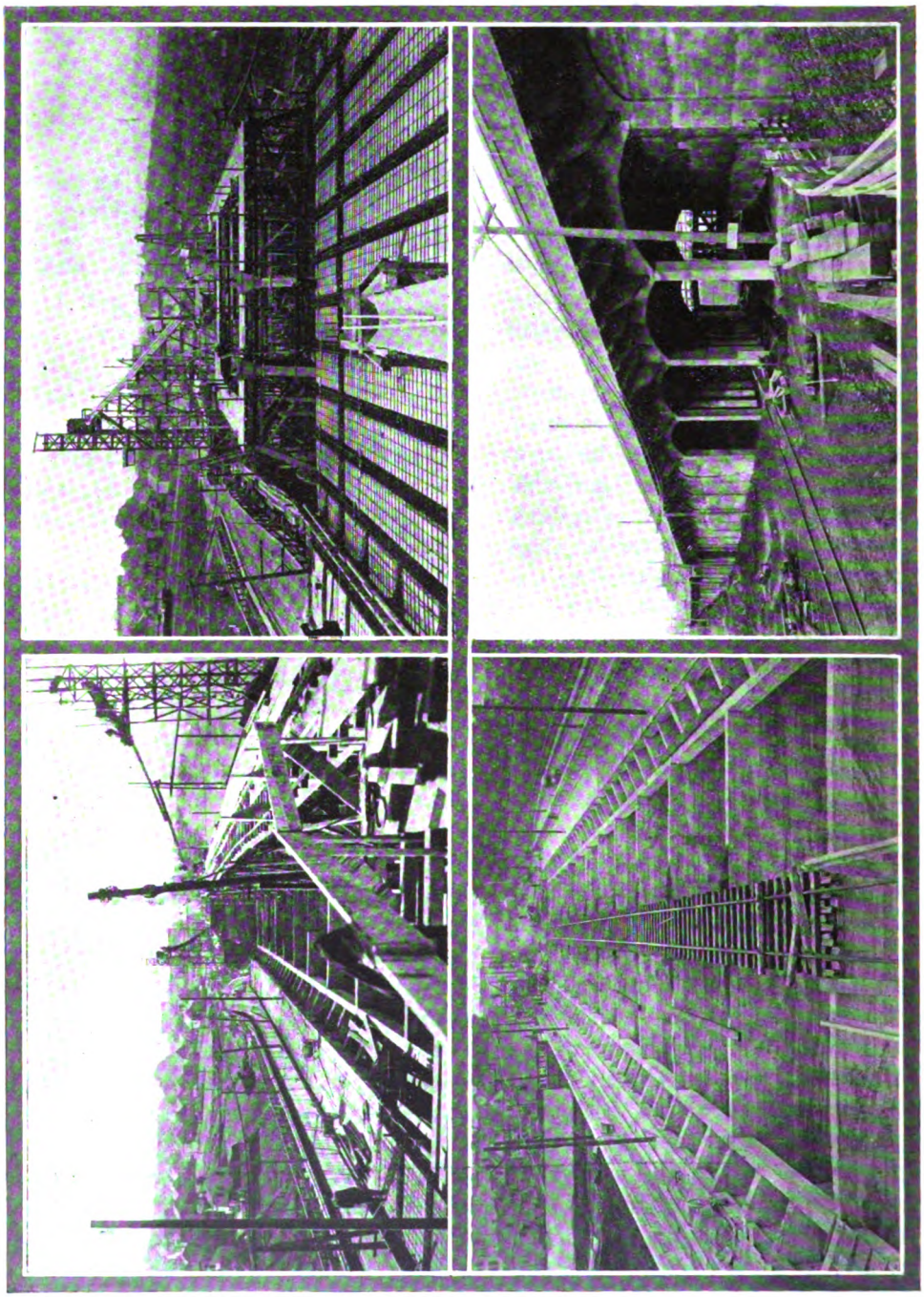

PREPARING THE FORMS FOR CONCRETE.
FORMS REMOVED.

READY FOR POURING.
THE COMPLETED VIADUCT.

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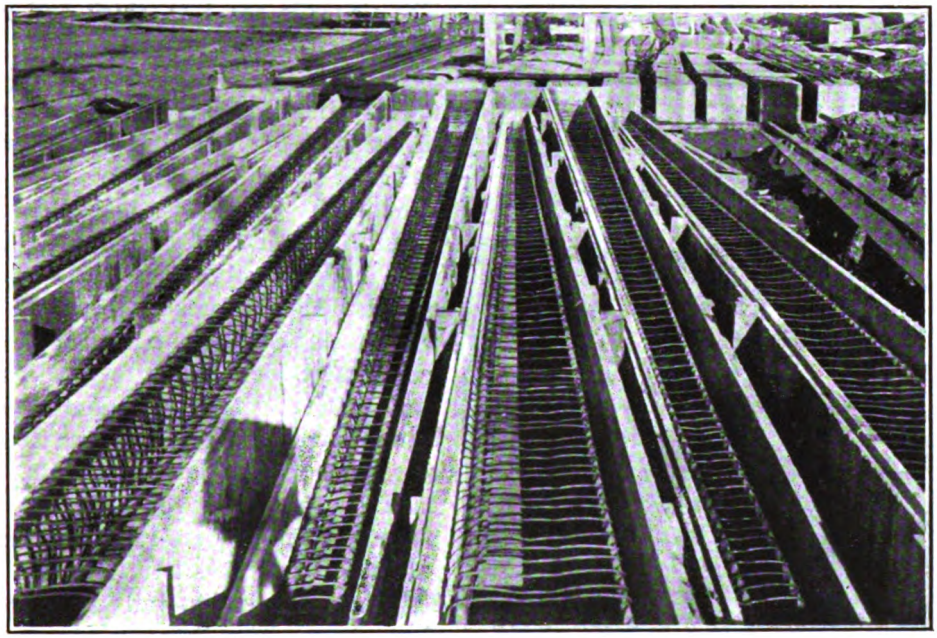
tion of approximately 27,000 cu. yd. of earth.

The structure rests on 788 reinforced-concrete piles. These were molded on the ground, allowed to season 45 days, and were then driven with a steam-hammer weighing 10,000 lb., having a moving part weighing 5000 lb., with a range of 36 inches. The piles were cast in various lengths, ranging from 18 to 30 ft., were 16 in. square at the butt, and battered uniformly on all four sides to an 8-in. tip. The piles were reinforced by four ¾-in. twisted rods running lengthwise and wrapped with No. 6 soft-iron wire. The wrapping was spaced 4-in. centres, except that 4 ft. at each end had 2-in. centres. The reinforcing was of such length as to allow 1 ft. at butt and 1 ft. at tip without any steel. This reinforcement was fabricated, suspended in wooden molds, and the concrete was then poured, molding the pile on its side. Care was taken to have molding platform of sufficient length to carry three or four tiers of piles. After pouring, the concrete was covered with sand and dampened each day for over a week. After 45 days the piles could be handled with block and tackle, snaked by team, and stood perfectly all sorts of rough handling in process of transportation from the molding platform to the drivers.



FORMS READY FOR POURING REINFORCED CONCRETE PILES.

In driving, the piles were protected by steel plates, ⅜ in. thick, made in two parts, and bolted together over the head of the pile with ⅝-in. bolts. The plates were 2½ ft. long and allowed room for fastening with a substantial clamp to the pile itself and held a 4-in. cushion of wood, a steel plate, and portion of a lignum-vitae follower. The plates were made to fit an 18-in. square surface and then wedged with 1-in. pieces of wood, to clamp rigidly to head of pile. This

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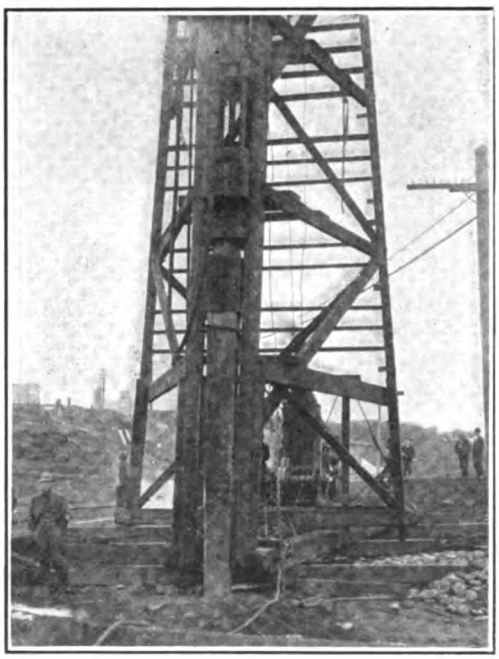
afforded sufficient protection, as is proved by the fact that 788 piles were driven to a penetration of 12 below to the last inch, with hardly a fracture of the head. The concrete used in making the piles consisted of 1 part of cement, 2 parts of sand, and 4 parts of crushed rock. Two kinds of sand were used, bank sand and ocean shore beach sand, and the rock had the following specification: two-thirds broken



DRIVING REINFORCED CONCRETE PILES.

to pass a 1¼-in. and rejected by a ⅞-in. screen, and one-third broken to pass a ⅞-in. and rejected by ⅛-in. screen. In addition to the piles, eight piers were carried down to bedrock. The material in which the piles were driven was a mixture of sand and clay in such proportions as to be liable to work if at any time it should come in contact with running water.

The side-walls act as retaining walls and have a thickness of 3½ ft. at base, batter on inside surface to 1 ft. 10 in., 2½ ft. from top, and then haunch out to 2½ ft. in thickness. The outer surface has indented sections, giving the effect of arches throughout. These arches are supported by pillasters 4 ft. wide and spaced 24-ft. centres. The wall reinforcement consists of ½-in. steel, vertical and horizontal, of twisted high-carbon type, ranging from 1-in. bars at bottom to ⅝-in. bars at top. The tie-walls are 1 ft. thick and reinforced with ½-in. steel, vertical and horizontal, ranging from ⅞ to ¾ in. cross-section. The walls have a double lacing with bars staggered at an average of 8-in. centres.

At each pillaster is placed a bulb beam in the form of a 78-lb. rail. This bulb beam is situated outside of the outside-wall reinforcement and the tie-wall stock hooks about it on each side giving a complete tie between both side-walls. On the inner side of side-walls, running from ¼ point of one section to ¼ point of adjoining section, and passing through the pillaster, are placed continuity bars ranging from ⅞ in. at bottom of wall to ¾ in. at top. This is general side-wall construction throughout. The distance between pillaster line on one wall to pillaster line on other side-wall is 63½ ft. This, with a 2½-ft. width on top of side-walls, gives a 58½-ft. roadway between curbs. The curb line consists of 3½ by 3½-in. angle iron held by ⅝-in. anchor bolts, 12-in. centres staggered, and was placed on form work and molded into the concrete. The sidewalk overhangs the side-walls a distance of 9 ft. ¾ in. and allows a clearance of 4¼ in. on both sides from outer concrete line and the property line.

The sidewalk is supported by ornamental brackets patterned after a deformed O. & G., and are 16 in. wide, spaced 8-ft. centres. The bracket re-

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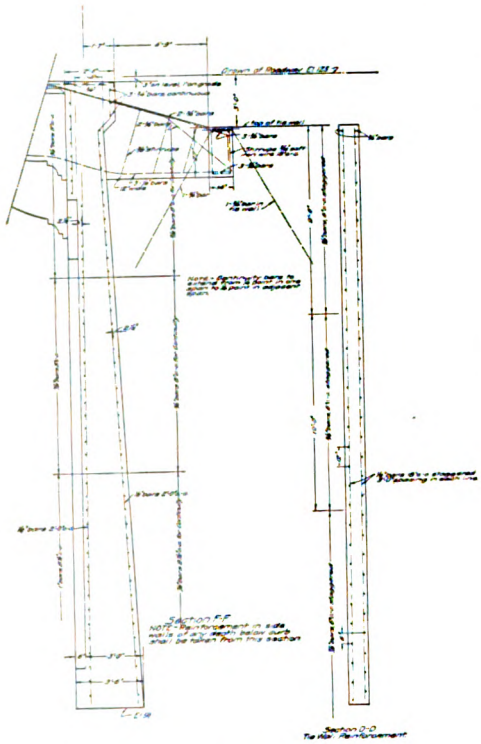
inforcement consists of four ¾-in. bars at top and three ½-in. bars at bottom, all tied by stirrups and extending

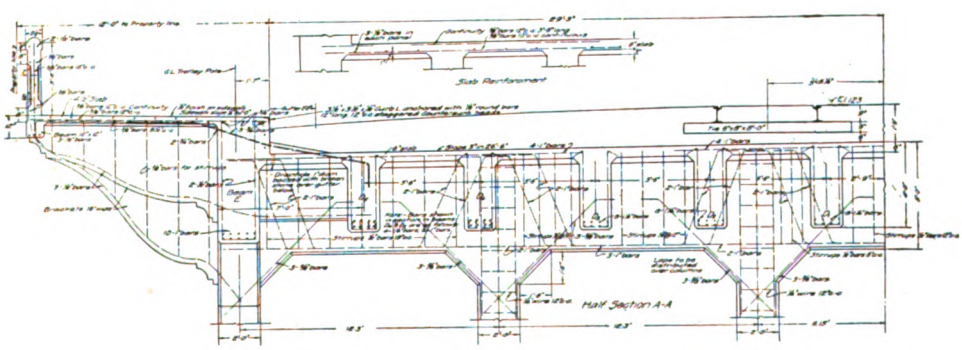


ELEVATION OF TIE-WALL.

through the side-wall to a 14 by 27-in. cantilever beam running parallel to the side-walls and 6½ ft. from same. This beam is reinforced with ¾-in. stock and is designed to counter-balance the overhang of the sidewalk. The sidewalk slab is 4 in. thick, with ½-in. wearing surface composed of 1 part cement to 1½ parts topping-gravel and lampblack, in the proportion of 1 bbl. of black to 8 cu. ft. of gravel.

At the tip of brackets is carried a 10 by 12-in. beam to support the sidewalk span. This beam is reinforced with two continuous ½-in. rods in bottom and four ½-in. shear rods. The sidewalk slab reinforcement consists of ⅜-in. stock throughout, parallel and transverse rods with 10-in. centres. At outer edge of sidewalk the hand-rail rises to a height of 3½ ft. above sidewalk. This is ornamental in design, having 8-in. posts and indented panels. The posts are placed directly above each bracket. The top of the railing is finished with a half-round coping, 8 in. wide. The handrail ends with ornamental newel posts.

On either side of Springdale street are placed retaining walls, backed by heavy buttresses and resting on a slab of concrete 15 ft. wide and 3 ft. thick, all heavily reinforced with bars of various sizes from 1¼ to ½ in. These walls are each supported by a mass of concrete pile. The north retaining wall has an additional support of two piers to bedrock which serve to protect a working chamber situated adjacent



HALF-SECTION OF VIADUCT, SHOWING LATERAL REINFORCEMENT.

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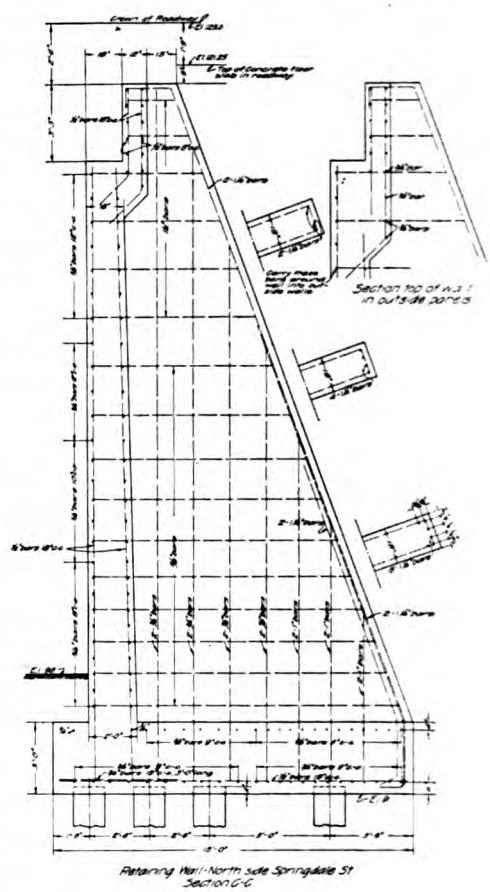
thereto which gives access to a 4-ft. by 6-ft. 6-in. sewage tunnel of reinforced concrete and which is being driven through solid rock for a distance of 1⅛ miles. The concrete span over Springdale street is supported by columns, beam, and girder construction. The columns rest on bases 6 ft. 8 in. square and 2½ ft. thick, reinforced with a grillage of ¾-in. bars 6-in. centres. Each base rests on five reinforced concrete piles. The columns are 24 in. square, with chamfered corners, reinforced with ¾-in. vertical stock and ¼-in. iron stirrups. The vertical stock runs from base into floor slab above. The girders, two of them, are each 5 ft. deep, 2 ft. wide, and 63 ft. long, and are supported on either end by 2 by 3-ft. columns and four intermediate columns. The beams are 18 in. wide, 4 ft. deep, and 60 ft. long. There are 10 of these beams, each having a 12-ft. span between girder and retaining wall at either end and centre span of 36 ft. These beams are spaced 5½-ft. centres. The reinforcement in the beams consists of 1 in. and 1¼-in. continuous bars, 1 in. and 1¼-in. shear bars, 1-in. continuity stock over each girder, and ½-in. stirrups. The girder reinforcement is chiefly 1-in. and ¾-in. stock with ½-in. stirrups. Each column haunches out at bottom of girder. The side-walls are carried over these sections by arch beams which also carry the sidewalk. The floor consists of a 6-in. slab of concrete, reinforced with ⅝-in. bars running transversely, 10-in. centres, and ½-in. tie stock. Five-eighths-inch continuity bars are placed over each beam.

The section at the Ocean Shore is similar to the Springdale section. The girders are 5 ft. deep, 22 in. wide, and 90 ft. long. The beams are 137 ft. long and supported by three girders cutting the section into four spans. Six 2 by 3-in. columns and twenty-one 22-in. square columns support this section. The interesting feature here is that the centre lines of beams and girders make an angle of 31° 46″ with each other. The retaining walls on either side of



NORTH SIDE RETAINING WALL.

this section run at an angle of 31° 46″ to main line of bridge. Their construction is similar to those at the Springdale section. They are each supported by 95 concrete piles, while the north wall has four piers to bedrock.

The completed structure gives a roadway 58½ ft. between curbs and a 12-ft. sidewalk on either side. The roadway accommodates a double-track in-

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terurban and local street railway and is paved with a basalt block pavement with asphaltic cement joints. The north end of viaduct has an earth-filled approach 360 ft. long, and the south end approach is 727 ft. long. The compartments previously described are filled with sand and water-tamped. Forty thousand cubic yards of sand was required. At the north approach 6000 cu. yd. of fill was required, while the south approach required 20,000 yd. of fill. The surface of concrete is plastered by means of a cement-gun which shoots the sand and cement, mixed dry at 3½ to 1, through a hose under 35 lb. pressure. At the nozzle of the hose is connected a water spray which can be regulated to give the mixture any required dilution when it reaches the wall. This process, though rather new, gives most satisfactory results. The bond between the rough concrete and the finish is perfect. The appearance of this finished work resembles a sand finish, which fills all voids and is very uniform in color.

In construction of the viaduct two mixes of concrete were used. The main side-walls, tie-walls, and footings were poured 1 part cement to 7 parts aggregate; while the columns, beams, brackets, and hand-rail was a mixture of 1 part of cement to 6 parts of aggregate.

The structure varies in depth from 15 to 32 ft. and raises the grade at lowest point from an elevation of 90 ft. to an elevation of 123 ft. Four hundred eighty feet of the structure and the north approach is constructed on a 4% grade. The balance of the structure and 67 ft. of the south approach is level, while the balance of the south approach has a grade of 3.38%. The entire length of structure and approaches, which represents the length of permanent improvement, is 1900 feet.

The problem of drainage has been carefully cared for by catch basins placed at various points where they will give most efficient service. Four of these were molded with the side walls of the viaduct. Trolley poles were also imbedded in the side walls as they were poured, and every portion of the work is as permanent as modern engineering methods can make it.

The cost data on this work have not been completed, so very little information in that line can now be given. The cost of the entire improvement amounts to $215,000, a small expenditure considering its value to the community.

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Comments on Irrigation Congress

By FREDERICK H. NEWELL*

THE Irrigation Congress at Salt Lake City, September 30 to October 3, 1912, was well attended, notably by delegates from Utah and adjoining states. The papers read were largely technical in character, having to do with the use of water, improvements in methods of agriculture, the obtaining of markets, more and better irrigators, and related subjects. There was a notably small attendance of the typical promoters such as have been conspicuous at former meetings, due largely to the fact that many dubious irrigation schemes have recently failed and it is no longer possible to float irrigation securities based on undeveloped localities.

Senator Newlands presided and was the central figure. There were present also Senators Smoot and Sutherland, and Representative Howell, of Utah. Governor Oddie of Nevada, and several state engineers, land commissioners, and other state officials were also in attendance.

One of the principal questions raised was as to the desirability of continuation of the Congress, or of merging it with other bodies such as the Trans-Mississippi Congress, the Dry-Farming Congress, etc., in order to economize in time and effort. It was concluded, however, to continue a separate existence and hold the next meeting at Phoenix, Arizona. Major Richard W. Young, formerly of the United States Army, now a prominent attorney of Salt Lake City, was elected president. Most of the officers are men who are not immediately identified with irrigation, but are interested in Western development.

The resolutions passed were brought down into as small a compass as possible and were quite general in nature. They practically repeated the resolutions of former congresses, endorsed the Newlands River Regulation bill, and expressed approval of the work done by the Department of Agriculture, etc.

Seepage and the destruction of a considerable portion of each project by alkali and swamping was an important topic. It appears that under the larger systems where compact areas of land are provided with an adequate stored supply, there is an excessive application of water, the ground-waters are raised near the surface, already from 10 to 20% or more of the best land is being ruined. In the San Luis valley, in Colorado, it is claimed that over 500,000 acres have been destroyed, including some of the best farms in Colorado; yet there is a constant cry for more water. On one of the Government Projects, the Shoshone, already 13% of the land has been injured, yet at the same time there is the most vigorous protest on the part of the average farmer against measuring his water-supply and controlling it to the point of actual needs.

One of the most interesting discussions was that which brought out the

*Director U. S. Reclamation Service, Washington, D. C.

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fact that with a given amount of water per acre certain crops could be produced, but with the same amount of water on twice or three times the area the crop values were increased. In other words, with a small amount of water, less than the average farmer thought possible for success, the crop production was at the maximum, while with more water the crop production rapidly decreased.

Immigration Agents.—At the time of the meeting of the Irrigation Congress there were held various other conferences, notably of state immigration officials and railroad men interested in promoting the settlement of irrigated lands; also of delegates from various water-users associations under the Government projects.

From the standpoint of the Reclamation Service, one of the most interesting features was the conference of these state and railroad immigration agents and their discussion of ways and means of getting practical irrigators on reclaimed lands. A great part of the area which has been brought under irrigation by private and public capital is not being utilized, and the crops produced are not of sufficient value to justify continuation or extensions of the projects or to enable the average farmer to pay his debts. In some cases there is lack of markets, as, for example, for alfalfa, where no provision has been made for disposing of it, and the bountiful crop is stacked in the field with no prospect of selling it for much more than the cost of cutting and stacking. Probably one-third or more of the land in each project to which water has been brought at great expense is not being cultivated. The problems as developed are as follows:

a More and better farmers on the lands now irrigated;

b Better average crop production for the lands which are cultivated;

c Better markets for these crops.

There are plenty of examples of success on each project to show what can be done if the average farmer will use less water and more brains in his operations. The human element is appreciated to be the vital point in future success under the large private and public systems.

Federation of Water Users.—Another conference which was held at the same time was that of delegates from a number of water users associations under Government reclamation projects. The sessions of these delegates were not open and were evidently protracted and stormy. Most of the delegates came apparently with some grievance, but few of these could agree; the complaint of one man was frequently met by an exactly opposite complaint on the part of another; one delegate, for example, urged that rotation of delivery of water was impracticable, another man claimed that continuous delivery was equally repugnant. Many of these delegates were not experienced farmers or irrigators, being often lawyers or professional men living in town and owning or hoping to own a farm in the country.

After several days of discussion among themselves, I was invited to meet the delegates. I had about three hours informal discussion of the operations under the Reclamation Act. Later the delegates met Senator Newlands and then Representative W. R. Smith, Chairman of the House Committee on Irrigation. The results of the meetings of these delegates are embodied in a series of resolutions which call for extension of time of payment and turning over the projects to the water users at the earliest possible date. These

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resolutions are of the nature of a compromise between many extremely Socialistic views and novel ideas which had been urged by the delegates. Taken as a whole, there was nothing very striking about them. They touch very lightly upon the real problems of irrigation farming, and relate rather to the speculative features inseparably connected with development work.

As an outcome of all the discussion, the following topics are conspicuous:

Repudiation.—Throughout the conversation of the delegates, especially those from the water users associations, in talk in the Congress and elsewhere, there ran an undercurrent of sentiment that the works executed by the Government should be paid for only in part, or, if at all, over a longer period than ten years. Some of the men urged twenty years for repayment, others thirty, and others were outspoken in the assertion that the Government should not be reimbursed either for the cost of construction or even for the operation and maintenance of the works, on the ground that the Government is rich and is appropriating money freely for the protection of overflowed lands and for other purposes for which no reimbursement is sought. This attitude at one time became so conspicuous that Senator Newlands, as president of the Congress, took occasion to deliver a vigorous speech in which he voiced what he believed to be the sentiment of the majority in condemning unqualifiedly the idea of repudiation. In this he was joined by Senator Smoot and other prominent men.

Cost of the Works.—In excuse for repudiation of a part of the cost at least, it was urged that the works as built by the Government had cost more than was anticipated, and there was continual vague reference to extravagance, etc. No definite examples were given, but it was urged that under the eight-hour law the work must necessarily be more expensive than otherwise, and that the requirements of Congress of frequent investigations and other matters made the works more costly than they otherwise should be, and that deductions should be made on this account. Particularly in operation and maintenance, the water users urged that as soon as the works are turned over they can employ cheaper men, avoid the requirements of the eight-hour law, and cut down the expenditures.

On the other hand, it was shown that although Government work possesses some disadvantages, yet in actual construction many notable economies had been practised on a large scale, and that the works as built compare very favorably in cost with any private enterprise equally effective. In fact, most of the private schemes now on foot contemplate far larger expenditure per acre, and those which have recently been built, furnishing a less dependable supply, have actually cost more than the average of Government works. If a valuation should be made today under any accepted rules, the Government projects would undoubtedly show a value far above the actual cost, whether this is based upon cost of reproduction, upon earning power, or other basis. The men who attempted to show that the Government work was extravagant failed in any case to make their points and trusted wholly to generalities.

Grievances.—The delegates from the water users association all had grievances, and there was apparent a general tendency to complain. I have recognized this condition and have had careful inspectors go through the projects to try to ascertain the basis of existing complaints. In particular, C.

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J. Blanchard has visited a large number of projects, devoted his time almost exclusively to the grievances, has investigated over a thousand of these, and has been able to find and rectify a half dozen or so which were really worth attention. His statement is to the effect, however, that over 95% of the complaints come from men who are not living upon the farms and cultivating them, but are spending their time in town complaining about the law, its administration, and the hardships and misfortunes of pioneering. The people on any project may be classified into two groups. First, the real farmer who is living on his farm and who has no other occupation. All his strength and energy are concentrated on making his farm a success. A man of this class, while not always optimistic, has no time to attend public meetings or discuss his troubles. He is usually too independent and too busy to do so. Every reasonable effort is being made to ascertain them and remove the cause, if he has any real complaints. The second class, unfortunately quite numerous on irrigation projects, consists of the men who consider agriculture as a secondary occupation, who are trying to make their living as lawyers, school-teachers, clerks, etc., in town, and who are either renting their farms or trying to operate them at a distance. This is the class from which fully nine-tenths of the complaints come.

Disappointments.—There is no doubt but that the majority of the second class above noted are bitterly disappointed with irrigation and with the efforts made by the Government or private corporations in building and operating irrigation works. They have come into the country largely with the hope of immediately bettering their condition and are little fitted for real pioneer work on the farm. They have had to learn that few, if any, men can succeed at farming as an adjunct to some other work, and attribute their lack of success primarily to the Government and its agents. They are becoming less in number because of the fact that it may be said that they are doomed to failure; it is one of the objects of the state and railroad immigration agents to enable these men to sell out to real farmers who can and will make full use of the opportunities presented.

Excessive Cost.—The matter of excessive cost of Government work has been shown to be attributable largely to the demand made that the Government in building its works shall bring them to a degree of completion far larger than was anticipated, such, for example, in an elaborate distribution system, in providing bridges and culverts, and a great number of smaller structures which under pioneer conditions in co-operative work the farmers have been content to do without. Even today with a large cost per acre, there are constant importunities for the addition of other features, such as power plants and local newspapers, while petitions of public bodies are calling for high-line canals or structures, whose cost will be notably great, on the plea that while the Government is building the works they should be designed to cover the greatest possible area and provide maximum facilities.

At the same time, while the Reclamation Service is being urged into these lines of large expenditure, the same class of men are complaining because similar requests made in past years have been acceded to and the structures thus built have added greatly to the cost of the irrigation works. In short, before completion, the public

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joins in demands for large expenditures, the assertion is made that the land will easily stand $50, $75, or even $100 per acre. When built, the reaction sets in; often the same men who have strenuously urged large expenditures are now violently condemning them.

Control by Water Users.—One of the chief items of discussion was the desire of water users to have immediate control of the works. Carefully analyzing this, it appeared that this desire did not come so much from the real farmer on the ground as from the real estate dealer and lawyer in town, especially the man hoping for employment, his idea being that all the work should be done by local men, excluding outsiders. The man on the farm is chiefly interested in getting his water at the right time; the slight reduction in cost which theoretically might be possible under local management he appreciates is only 1 or 2% of the other items of his expenditure. On the other hand, the risk run in putting the large works in inexperienced hands might result to him in complete crop failure.

Experiments that have been made of trying to turn over part of the system to the local men to operate, in all cases met with disaster because the community as a whole has not become consolidated. There is continual shifting of ownership and none of the neighborhood feeling which assures coöperation. The little farmer at the end of a long lateral has no protection against the greed of his neighbor a mile or more away, who is indifferent whether he gets the water for which he pays. As a result, under local control these men have been almost ruined and are bitterly opposed to transferring the control until the whole community has been educated up to an appreciation of the necessity of fairness in handling water. The farmer has no assurance that his partners in handling a lateral or a part of an irrigation system will respect his rights if it involves additional labor and expense to them.

Theoretically there may be an agreement that the system should be turned over to the water users as a whole at the earliest possible date, but none of the Government systems are in such degree of completion, and the population is not yet sufficiently stable to justify this at present, although every effort is being made to make provision for such transfer. Meanwhile, the methods and organization must be perfected and good service rendered at the minimum of cost, educating the people as a whole by good service to a point where they can understand and appreciate the advantages of effective handling as well as the difficulties and dangers of inexperience in such matters. A sense of the value of coöperation would benefit all concerned.

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Future of Oil Production in California

By R. P. McLAUGHLIN*

HOW much oil remains in the ground in California? This question is of vital importance to any interests contemplating investments which depend more or less directly upon the fuel supply. A complete estimate is far beyond the scope of any article such as this, as is illustrated by the fact that the large marketing concerns have statistical departments constantly gathering data on this subject. However, some facts bearing on the question may be presented in concrete form, serving somewhat as a yardstick in measuring, or rather estimating, the possibilities. Such an illustration may be most readily obtained by considering the fields along the west side of the San Joaquin valley, as they are nearly enough adjacent to one another to be readily taken in by a glance at the map. They have been rapidly developed and are producing the greater portion of the total output.

The estimate as here outlined will merely deal with areas of possible land and a comparison with other areas which have produced a definite quantity of oil and are approaching expansion. Exhaustive appraisals frequently depend upon two factors, thickness of productive oil sand and its percentage of saturation. Such estimates are lost in the maze of their own figures, for the simple reason that as yet there is no known method of determining and recording how much really productive sand there is in a California oil well, and, furthermore, we as yet know but little of the movement of oil underground and how much could be extracted from a saturated sand.

Another method used is to plot production-curves for individual wells and from a study of their rate of decline, estimate the length of life of each well, which, coupled with the total production and area per well, can be applied to a given area. This method is subject to the objection that neighboring wells sometimes act very differently. Even in a field where alternate areas have been exhausted, an estimate of the remaining areas based upon a comparison of average total production would be unreliable, owing to the possibility that the exhausted land had drained a portion of the undrilled territory. Hence the reader may be prepared to excuse apparent inaccuracies in an attempted large estimate in short space.

The accompanying map shows the field of the west side of the San Joaquin valley, and gives an idea of the developments during the past four years and some idea of what the future holds. In 1907 and 1908 the U. S. Geological Survey examined this territory and outlined, on the map, such land as was thought to be productive to depths as great as 4500 ft. At that time there was considerable oil land of actually

*Consulting Engineer, Mills Building, San Francisco.

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proved productiveness. Since then, more land has been developed and shown to be productive, while considerable land has been demonstrated to be unproductive. These four divisions of land are shown on the accompanying map. The portions marked as proved have producing wells over nearly their entire area and allow for little or no surmise as to area. The disproved areas cannot be so closely defined, but are, as shown, based upon knowledge of the developments and geological conditions obtained by my observations during the past four years, and are believed to be very conservative. Separate districts will be especially mentioned later.

The area, in square miles, of the various classes of land shown on the map are as follows:

	Productive oil territory, U. S. G. S. 1907-8 estimate	Proved territory before 1907-8 estimate	Proved since 1907-8 estimate	Probably disproved since 1907-8 estimate	Proved outside of estimate	Undeveloped
Coalinga	89.1	12.2	7.4	...	...	69.5
Kettleman	38.6	...	...	38.6	...	...
Kreyenhagen and Devils Den	47.6	...	...	...	...	47.6
Lost Hills	31.2	...	2.0	...	1.0	29.2
Belridge	...	...	...	...	2.2	...
McKittrick, Midway, Sunset, Buena Vista, Elk Hills	528.0	12.5	40.6	51.2	...	423.7
	734.5	24.7	50.0	89.8	3.2	570.0

The Coalinga field, of all those along the west side of the San Joaquin valley, is most susceptible to accurate estimates, due to simple geologic conditions and small area. The estimated original territory has been but slightly altered by developments, that is, there have been no new discoveries outside the area and not much definitely disproved within it. However, the undeveloped land, about 25 miles along the western side, simply covers all possibilities of finding even slight quantities of oil back to the lowest outcrop, and it has been shown to be of slight average value compared to the present producing land. In a large estimate it might be ignored. On the other hand, the eastern border has, in places, been shown to be deeper than supposed in the estimate. This fact, together with the increased difficulty of working, would materially reduce the probable productive area. Therefore, of the 69 square miles of undeveloped land in the field, it would be safe to consider probably not over 25 square miles to be of value as compared with that of other productive fields. Almost none of the proved land in the field is entirely drilled, and none has been pumped to exhaustion. The Kettleman Hills land was at one time considered as a very promising prospect, but several wells in the most favorable situations have in two years of almost constant work,

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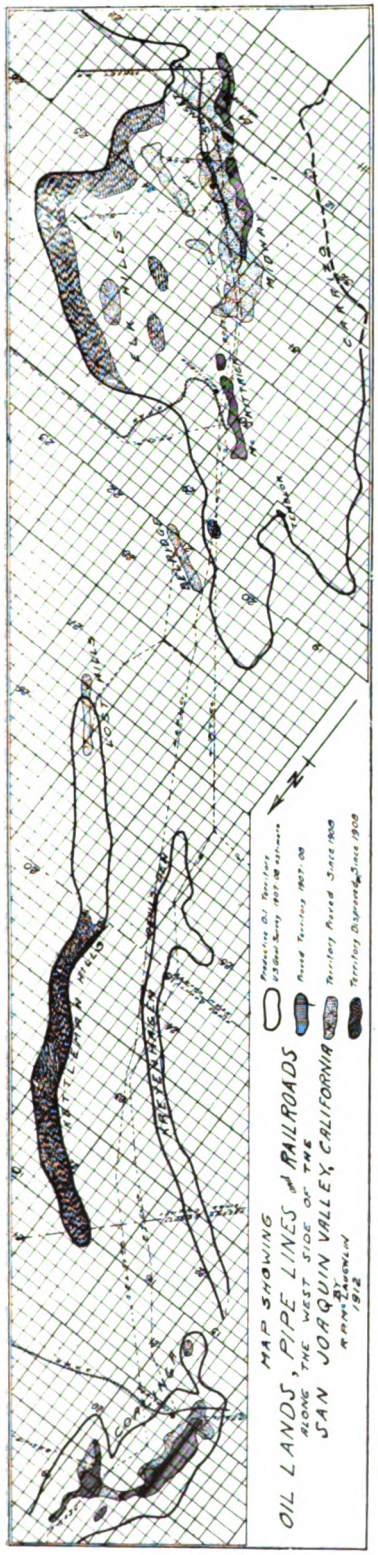

reached depths of about 4000 ft. without showing oil. If oil should yet be discovered, the original estimated area would be reduced to a very small amount. Therefore this land has been considered as disproved.

The Kreyenhagen and Devils Den regions have been prospected with several wells during the past four years. Some oil has been found, but no producing wells. A portion of the land within the original estimate would be very difficult to drill, owing to the steep dip of strata, and, in conjunction with the negative results of operations, 10 square miles of the 47 undeveloped would be a very liberal estimate of valuable land. The Lost Hills district raised the hopes of operators to the pitch of excitement when discovery was made in the face of adverse predictions, but many have been disappointed at the narrow streak of proved land after more than two years of active development. Of the undeveloped 29 square miles in the original estimate, it seems extremely liberal to classify 5 as being probably highly productive.

Possibilities of the Belridge district and its neighborhood are difficult to estimate. It lies entirely outside the land originally classified as oil-land and its strange occurrence is emphasized by the fact that nearby land within the original lines has been disproved by deep drilling. Other wells to the north and east tend to limit the possibilities, and not more than five square miles in the neighborhood could be safely called probable. The remainder of the oil lands, constituting the McKittrick, Midway, and Sunset fields, together with the Buena Vista Hills and Elk Hills, naturally fall in one large natural division and will be so considered here. It is to be noted that developments since 1908 have increased the proved area

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more than three times and that the original estimate shows about ten times as much oil land as is already proved. However, the estimate covers a great deal of land of very doubtful value. The southwestern limit of proved area is, as a general rule, the outcrop of the northeasterly dipping oil-formations and therefore the land farther to the southwest, over Temblor range, is valuable only for the possibilities in the underlying formations.

There are several thousand feet of brown shale (Monterey) formation, with occasional thin lenses of sand, some of which have been shown to carry oil, but the shale has thus far proved to be barren. The possibilities of the formation under the thick deposit of shale have not been tested. In the Carrizo district several wells have penetrated the formation lying above the shale, but without success. Hence this southwestern area of about 225 square miles should not be considered in a valuation of probable productive land. The original estimate as applying to the Elks Hills is greatly reduced along the eastern margin, owing to the fact that the oil formations have been found to lie at a very much greater depth than was supposed, and also some wells have been drilled in the region that tend to actually disprove portions not along the margin. Intimate knowledge of the developments and geology indicate that not more than 75 square miles should be figured as valuable.

With the above explanations kept in mind, another column can be added to the statistical table, following highly probable undeveloped land.

Therefore, with liberal deductions, there is 198 square miles of oil land proved or highly probable, along the west side of the San Joaquin valley.

For a standard of comparison as to

	Highly probable undeveloped ..	Total proved and probable .....
Coalinga	25	44.6
Kettleman	..	...
Kreyenhagen and Devils Den..	10	10.0
Lost Hills	5	8.0
Belridge	5	7.2
McKittrick, Midway, Sunset, Buena Vista, Elk Hills	75	128.1
		197.9

the amount of oil to be expected from a given area in the San Joaquin valley, the Kern river field offers the most data. It has been producing for more than ten years, and some properties are about exhausted. Ten barrels per day per well is a figure frequently used in defining exhaustion, and is so considered here. Probably the future will some day require the lowering of this limit.

Probably there is no complete list of production figures for all the various properties of this field, and much labor would be required in tabulating such results as have been preserved. However, the production of a great number of properties has been investigated by me indicating ultimate production of from 12,000,000 to 50,000,000 bbl. per square mile, and an average of 20,000,000 bbl., depending upon the location in the field. Incidentally, it may be mentioned that the same figures show that with the present rate of drilling, and with continuous pumping, the Kern River field as a whole may be expected to last for five to ten years. This includes no land outside of that which is at present actually proved. Therefore the above figures, with accompanying

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explanations, cover 198 square miles of land along the west side of the San Joaquin valley, bearing 20,000,000 bbl. of oil per square miles, or a total of 3,960,000,000 bbl. It should be noted that this method of estimation gives a much lower total than that used by the U. S. Geological Survey in the Coalinga field, being only about one-third of that particular field.

The record of past production from these fields is as follows, the figures from 1909 to 1912 having been kindly furnished me by R. W. Dallas and the previous figures being taken from U. S. Geological Survey reports.

	McKittrick	Midway	Sunset	Coalinga	Total.
1900		892500		532000	1424500
1901	430450	4235	188600	780650	1403935
1902	619296	3048	167558	572498	1362400
1903	658351	5000	250000	2138058	3051409
1904				5114958	5114958
1905	276171	11033	302701	10967015	11556920
1906	531185		409335	7991039	8931559
1907	1944671	134174	567175	8871723	11517743
1908	2517951	410393	1556263	10386168	14870775
1909	5098579	2019952	1647561	14478181	23244273
1910	5480631	11168834	9149159	18597301	44395925
1911	5349619	20967011	4625731	18580333	49522694
half 1912	2469357	11779049	2593134	9790123	26631663

Production of Coalinga from 1897-1900 (663,512 bbl.) and figures omitted in above tabulation would probably increase the total about 1,500,000, making the total production to date 204,528,754 barrels.

The figures of area and production herewith given show that the 75 square miles of actually proved ground have already furnished a little over one-seventh of their total oil content, estimated at 20,000,000 bbl. per square mile, and that the total area, proved and highly probable, has been exhausted of about one-twentieth of its total content. The remainder, at the present rate of production, about 50,000,000 bbl. per year, would require 75 years for exhaustion. The annual production will probably increase to meet extended consumption, thus shortening the above estimated length of life.

Data for extending this method of estimate to the entire state of California are not at hand, but doubtless the area here considered is considerably more than one-half of the probable total. There are possibilities that other territory at present unexploited will in the future prove productive. However, a rather comprehensive knowledge of the geologic conditions of the state warrants the statement that such possibilities are so few as to be practically negligible and in fact are much less than ordinarily supposed.

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The Low-Temperatures Laboratory at Leyden*

By G. BRESCH

THE most remarkable installation for the continuous production of very low temperatures is that of the laboratory directed by Kamerlingh Onnes, professor at the University of Leyden. His work has made possible the investigation of the most diverse natural phenomena, under temperatures down to within a few degrees of absolute zero. The importance of these investigations already had been foreseen by d'Arsonval in the discourse he gave in Paris, October 12, 1908, at the closing of the First International Congress for Low Temperatures.

"The ultimate consist of matter," he said, "and the nature of electricity, can be made known to us when we shall study them at approximately absolute zero (-273°C.) The discoveries made in the work of Curie, Thompson, and Rutherford now show to us the atom, a solar system as it were, exceedingly small; it consists of an astonishing rotation of electrical corpuscles containing, in spite of their exceedingly minute size, effective forces many million times greater than the energy of our most powerful chemical reactions." Thus, in a hydrogen atom, namely something a million times lighter than a millionth of a millionth of a milligram, would be a thousand such corpuscles, named electrons, charged with negative electricity and under the attraction of the nucleus charged with positive electricity.

These electrons are separated one from the other by distances, relative to their dimensions, comparable with those of the planets of the solar system; they revolve one about the other with exceeding rapidity (of the order of many millions of millions of revolutions per second). Out of that wonderful activity is born the potential energy contained in the invisible dust which we call the atom. By means of a powerful magnetic field we can influence the normal orbits of the electrons and thereby capture these wonderful corpuscles; and by modifying the so-called solar system of the atom, can state precisely all the above named facts. The work of Professor Onnes on the conductivity of metals at very low temperatures shows us how to secure the powerful magnetic fields required. It is seen, consequently, that the study of matter at a temperature in the neighborhood of -270°C. can clear up the mystery of its composition. Therein is a question of the highest interest and one actively being discussed in all scientific circles.

The Production of the Extreme Low Temperatures in the Laboratory at Leyden.—The work of the laboratory is

*Original in *La Nature;* translated and abstracted from the August 1912 number of *Scienca Gazeto*, the official organ of the International Esperantist Scientific Association, by A. H. Babcock.

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purely scientific. It consists in the production and continuous maintenance of any temperature below freezing, and of preserving this temperature constant in the apparatus as long as it is desired. Such temperatures cannot be produced quickly and maintained; it is necessary to proceed by steps, namely, to produce consecutive small drops in temperature, every drop being produced by the use of an appropriate gas, which is put through a cycle of liquefaction and vaporization, the series of cycles of the gases comprising that which, in the low-temperatures laboratories, is called 'cascade.'

The cascade at Leyden consists of 5 cycles which make possible, by suitable variations in pressure, the realization of any temperature between 0 and -272°C. The methyl chloride cycle gives -90°; the ethylene, -160°; -200° is reached by the oxygen cycle; -259° by hydrogen; and, finally, -272° by the cycle of helium.

Professor Onnes, it is likely, soon will insert a cycle of neon between the oxygen and the hydrogen cycles. Neon is a gas that exists in very small quantity as a constituent of air; it is prepared now industrially by means of liquid air obtained by the process of M. Claude. Here are the different cycles:

The methyl chloride, liquefied, is sent into receiver No. 1, where it boils at -90° under reduced pressure; the cooled vapors are recovered by a pump, reliquefied by continued pressure, and again sent to the receiver. Consequently, always the same methyl chloride circulates continuously in the cycle, passing alternately into the liquid and gaseous states. In the second cycle the vapors of ethylene, compressed after being cooled by the methyl chloride vapors in a condenser, are liquefied in receiver No. 2. In the third cycle the oxygen is liquefied by means of the liquid ethylene vaporizing in vacuo. All these cycles operate by means of pure gases, and consequently are very carefully kept enclosed. The cooling apparatus of the third cycle serves to prepare the liquid air.

The hydrogen circulates in the fourth cycle. Cooled by liquid air at -210°, it is liquefied in a suitable container. The apparatus has a certain quantity of minute valves and capillary tubes in which the hydrogen is made to circulate. If some cubic centimetres of gaseous air should be included in some hundreds of litres of hydrogen (0.001%) circulating in the apparatus, this air, solidifying on account of the excessive cold, would plug the tubes and valves. Thus continued operation is possible only by the purest hydrogen.

Finally, in the fifth cycle, the helium, in its turn, is liquefied and vaporized. Two hundred litres of helium can be compressed up to 100 atmospheres, and circulated 28 times in 4 hours, and nevertheless preserve almost absolute purity. Such purity is necessary, even more than for the hydrogen, on account of the exceeding thinness of the capillary tubes. The helium that is used contains less than one ten-thousandth of foreign gases; its purity is controlled by means of the spectroscope.

Starting of the Different Cycles.—Nothing requires more methodical treatment than the starting of the cycles. When all is ready, Professor Onnes, standing near the principal apparatus, gives his orders to the observers and mechanicians. This is necessary because the apparatus must function one after the other, every machine immediately after the other, exactly in the predetermined order. The following time-table shows the time of beginning

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of the several cycles consecutively:

Time.

9:15 the first cycle begins.

10:00 the condensation of the ethylene begins in the second cycle.

10:37 liquid ethylene collects in the boiler.

11:50 the total quantity of ethylene has been collected; the vapor pressure is 155 mm.; the temperature cool.

12:09 the pressure of the boiling ethylene is 70 mm.

12:15 compressed oxygen is admitted to the coil of the third cycle.

12:44 the first spurt of liquid oxygen is received.

13:32 liquid oxygen at atmospheric pressure is received.

14:10 there is sufficient liquid oxygen under proper conditions to proceed.

16:45 the operation is completed.

Thanks to his great experience, Professor Onnes now considers it relatively easy to produce 60 cu. cm. of liquid helium in a few hours. This helium, vaporized under a pressure of 0.04 mm. of mercury, produces a temperature of −272°; it is the lowest temperature yet obtained.

Concerning the Researches Made in this Laboratory.—Scientists of all lands are made welcome at Leyden, where they can study the most diverse phenomena, such as the electrical conductivity of metals under very low temperatures, and the suspension of life in grains. Becquerel investigated whether at very low temperatures life in grains could be suspended for a time and made to reappear later at the will of the experimenter. He experimented with mustard seed, lucerne, and wheat. He bored through the covering of the grains in order to make them more easily penetrable. The grains, dried for six months in vacuo, later were placed for three months in liquid air at Leyden, and also were subjected for 77 hours to a temperature of −253° (by means of a bath of liquid oxygen).

On his return to Paris he placed the grains upon absorbent cotton at a temperature of +28°, where they germinated after some days. He observed no difference between their germination and that of grains under normal conditions.

The law of continuance of life phenomena, so often cited by physiologists, thus seems to be disproved. According to that law, life is a succession of uninterrupted phenomena, which, in no case, can be halted without inevitably causing death, and which being transmitted from generation to generation since their first appearance upon the earth, never have been and never could be interrupted.

The experiments of Becquerel do not accord with that law. Grains, and even the lower forms of animal life, often can be considered as if they were machines, inanimate but ready to perform their functions, as unwound clocks that only await the first impulse. These quasi-machines, these clocks, will begin to function only when warmth and moisture, the first vibration acting upon them, will produce the necessary excitation.

These experiments remove one objection offered to that theory, according to which the germs of life fill all space of the universe, and, meeting vagrant planets, disseminate life upon their surfaces, immediately when the conditions necessary to the life of those organisms are met. These germs, it was said, would remain during their wanderings in the intense cold of interstellar space and could not survive. Well, we know now that a temperature of −253°C. does

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not at all prevent their germination.

The Specific Heat of Solids at Low Temperatures. — The investigations of Nernst and his pupils show that the specific heats rapidly diminish when the temperature is lowered, and tend to become zero. Without going into details, it will only be said that these results shake the theories that up to now we most relied on. It is easy to understand now why so many scientists go to Leyden. How many new facts already have been discovered; how many old theories must be studied anew, examined according to the knowledge made available by those new facts! And science owes much to Kamerlingh Onnes, who created this laboratory and who places at the disposal of investigators the extremely low temperatures obtained by means of boiling hydrogen and helium.

Water Hammer

By S. L. BERRY*

THE following discussion of water hammer in pipe lines will include a short statement as to what constitutes and produces it, followed by the generally accepted formulae for calculation, and diagrams for steel, cast iron, Douglas fir, and redwood pipes. In conclusion, a reference list of publications is added for those who may wish to study the question in greater detail.

This article is written for the purpose of eliminating the laborious calculations involved, and, especially, to render the subject more easily understood in order that there may be a clearer appreciation by those who operate and work with pipe-lines of the pressure resulting from water hammer. In many cases it is the operator who controls the maximum pressures in the pipes, and it is well that he should know something of the conditions which bring about the results.

Water 'hammer' or 'ram' may be defined as that pressure which is produced in excess of the normal existing in the pipe, by closing the water outlet, either partly or completely, thus reducing the velocity of the water. Similar results occur when the valve is opened, the first pressure-change being below normal, followed by excess pressure. Were it not for the fact that water is compressible and the walls of all pipes more or less elastic, the pressure resulting from velocity changes would be much more serious in effect. A complete lack of compressibility in water and of elasticity in the pipe material would make the use of pipes impossible except to carry water at an absolutely fixed velocity. Under such conditions there would be but few developments of water power, as the water would have to be very carefully diverted from the wheel, and there could be no saving of water at light loads. It is fortunate that no such state of affairs has to be contended with, but it is none the less necessary to give due and careful consideration

*Consulting Engineer, Rialto Bdg., San Francisco.

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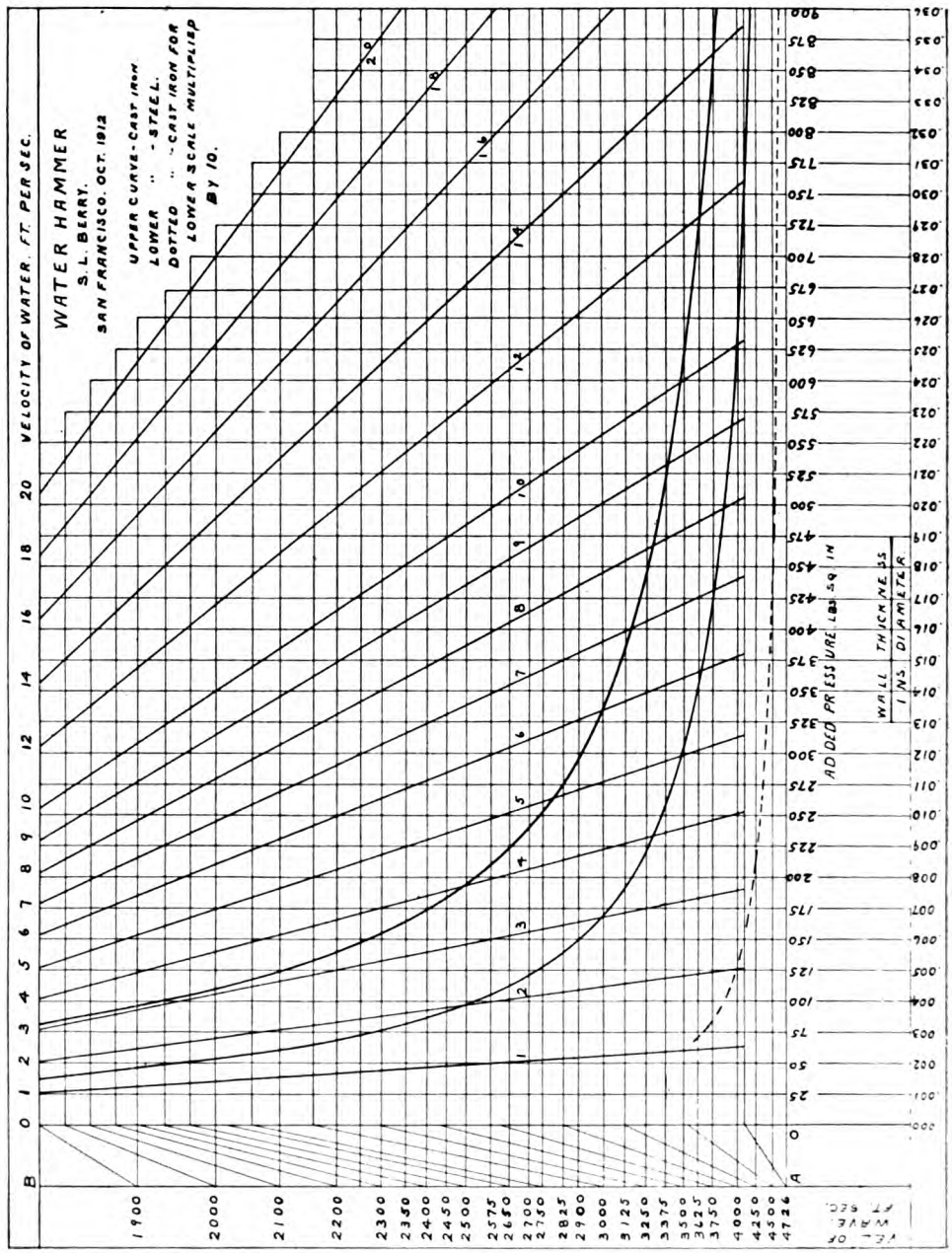

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to the conditions which actually exist.

When the valve in a pipe-line, or the regulating mechanism of a water wheel is closed, partly or fully, a decreased velocity and an excess pressure result, the amount of which depends upon the velocity which has been lost, the degree of compression which the water undergoes, and the stretch in the pipe. This increased pressure-wave starts at the valve, travels up the pipe with a velocity equal to that which sound would have under similar conditions, and which is dependent upon the same factors which control the ram-pressure. In fact, the pressure is calculated directly from the velocity of the wave.

In a pipe-line having no safety valves or air chambers, and consisting of pipe of the same diameter and thickness of wall throughout the entire length, the pressure wave travels to the reservoir where it drops to normal, and a wave of normal pressure travels toward the valve at the same velocity. On reaching this point, the pressure drops below normal, by an amount somewhat less than the ram, and a wave of subnormal pressure runs to the reservoir and back. In this simple case a gauge at the valve, if so made that it shows the pressures accurately, would rise to the ram pressure and stay there until the wave returned, when it would drop below normal for an equal time. The time of each of these cycles is found by dividing twice the pipe length by the velocity of the wave.

It is necessary to know this when determining the time within which the governor shall close the gates, for the reason that it has been found that if the gates are closed before the pressure wave returns, the ram is as heavy as though they had been closed instantaneously. Thus long lines are more difficult to control than short ones, and anything which increases the elasticity of the line, increases the time of the cycle, although it also decreases the amount of the super normal pressure.

Due to the fact that except under low heads and with short lines, there are few pipes of this simple nature, and because the ordinary gauge is not quick enough to accurately register such rapid changes, the above conditions are not likely to be indicated at the powerhouse other than by a violent vibration of the needle. With varying diameters and wall thicknesses of pipes, the wave velocity and amount of pressure will be different in each section, and it is necessary to consider them in conjunction to obtain correct results. The pressure conditions at the valve become too involved to be followed very far, but it can be stated that in most, if not all installations, the lower section produces the most ram. As this influence extends upward, it is necessary to see that the thinner upper walls are not overstrained. If it is found from the diagrams that the lower section will be subject to a ram pressure of 400 lb. and the next, if considered by itself, to 300 lb., the resultant to which the one will fall and the other rise will be found between the two. This may be taken at approximately 350 lb. where the diameters do not vary greatly. Similarly, in the third section, this pressure of 350 lb. will increase the pressure which the section would have to withstand were it not influenced by conditions below it. It is seen that high velocities and rigid pipes below, affect the safety of the lighter portions.

There will be a successive dropping of the pressure at the valve as the influence of the upper sections is felt, but the manner of this dropping and its extent become difficult if not impossible to predict, when the pipe has several

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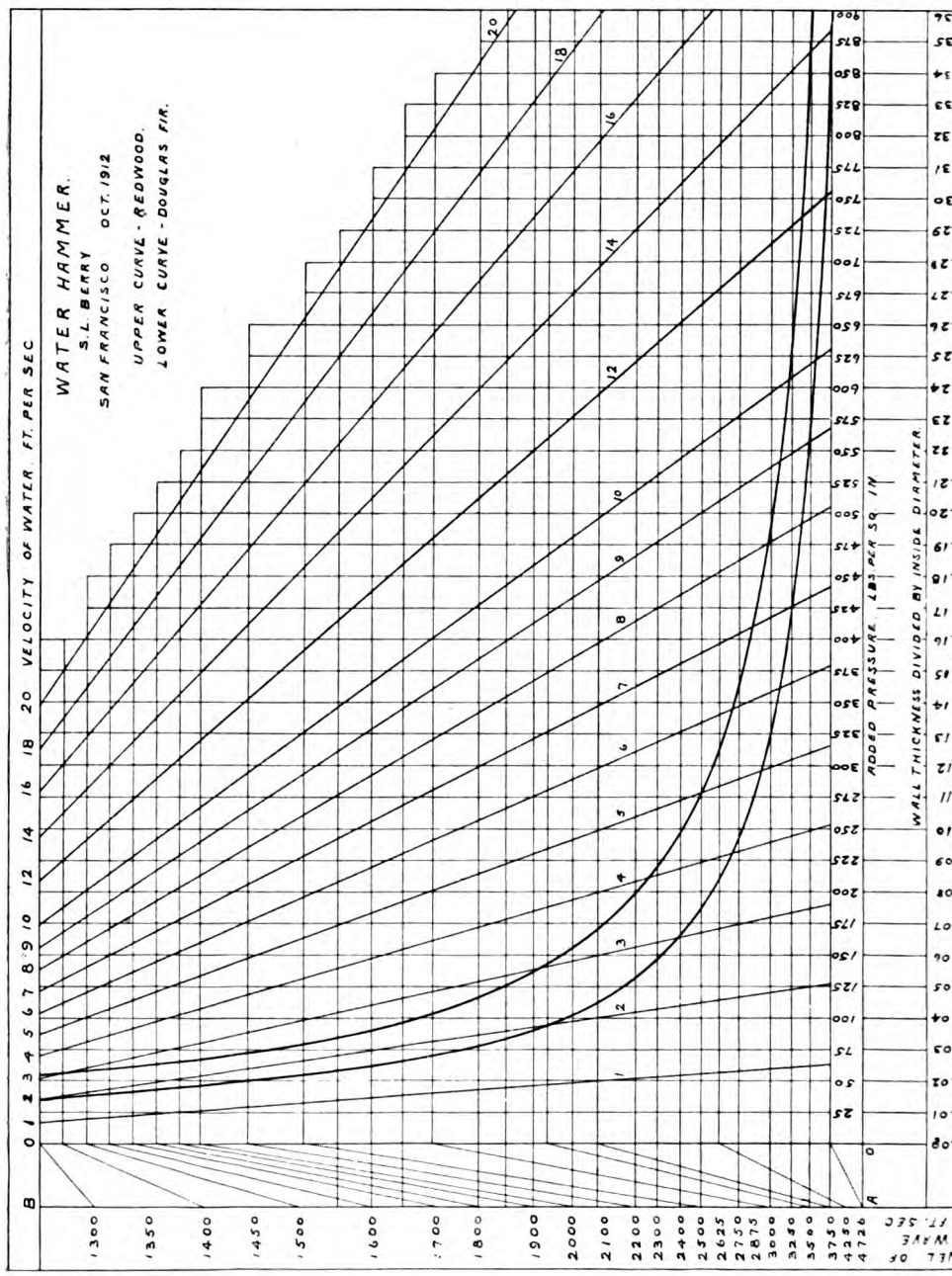

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sections of varying diameters and wall thicknesses. Where slow-moving regulating-parts and safety devices are installed, the above conditions will not, of course, occur, except when derangement of the machinery eliminates the protection.. The study of the worst possible conditions is of value in order to determine the kind and number of safety devices to be installed, and the amount of care in operation necessary to see that all are in good working condition.

In a recent installation that had a branched pipe-line, security depended altogether upon the proper working of the by-pass and safety valves. Both of these give excellent protection. Should the safety valves stick—a very likely occurrence if they are not frequently examined—safety is reduced to one element, more or less subject to derangement according to its construction. Eliminating the safety devices, the possible ram pressures are considerably in excess of the static, and the severest strains are found in the upper or lighter pipe.

The following explanation will apply to both diagrams. The lower row of figures represents the quotient obtained by dividing the thickness of pipe-wall by the internal diameter. Starting at this figure, follow the vertical line to the proper curve for the pipe material, then horizontally to the line A-B, showing values of wave velocity in feet per second, then along the diagonal to the line O-O, horizontally to the diagonal representing the velocity of the water and vertically downward to the row of figures marked 'added pressure.' The result will be the ram pressure produced in that particular pipe by closing the gate within the time found by dividing twice the pipe length by the 'velocity of wave.' Should the gate be only partly closed, take the difference between the velocity before and after the movement instead of the total; it is the velocity lost which produces the ram. The dotted curve for cast iron is an extension of the solid one above, and when used, the lower figures must be read as though multiplied by ten. All other figures are unchanged. It applies to cast iron pipes having ratios of wall thickness to inside diameter ranging from 0.03 to 0.36.

An inspection of the various curves will show that for a given diameter and thickness, steel gives the heaviest ram pressure, followed by cast iron, Douglas fir, and redwood. However, as cast iron is always used with heavy walls, it will be found in practice to exceed steel. Wood stave pipe gives low pressures but long periods of vibration. In these no account has been taken of the bands, as it is believed that the great difference in the elastic conditions will render the effects small.

Experiments prove that a pressure wave reflected from a dead end becomes doubled in intensity unless some water is flowing from it. With more than one unit taking water from a header, or from branches of a main line, simultaneous gate closure, or closure at intervals equal to four times the pipe length divided by the average velocity of wave, will produce pressures equal to the sum of the separate effects, while they will tend to equalize each other with movements at intervals equal to twice the pipe length divided by the average wave velocity. In the former case, dependence upon the safety appliance is much increased, and it becomes doubly important that the operator see that these are working properly. In all parts of a line, ram pressures should be kept low enough to prevent the following wave of sub-

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normal pressure from reaching the vacuum limit, for in this case the water column will be broken and violent shocks set up, and the pipe be subject to a collapsing pressure.

The diagrams have been calculated for instantaneous closing of the gates, but, as stated previously, the pressure at the gate will be the same for any time of closing less than that required for the wave to make the trip to the reservoir and back. For a time of closing greater than this, the pressure given should be multiplied by the round-trip time and the result divided by the closing time. The maximum pressure will reach the top of the line only when the gate is closed instantaneously, so there will be an average in slow closing even within the round-trip time.

For those who desire to study the derivation of the formulae a list of references is given, which, while probably not complete, is extensive enough to cover the field satisfactorily. The most important and extensive work in this direction has been done by Joukowsky, who had unusual facilities in an experimental plant connected with the Moscow water works. The following are given by Church in his 'Hydraulic Motors,' while values for the modulus of elasticity of the various materials have been taken from several sources, those for Douglas fir and redwood from Circular No. 189, Forest Service, U. S. Department of Agriculture, 1912, averaged for green timber.

Let

E = bulk modulus of water, 300,000 lb. per sq. in.

E' = modulus of elasticity of the pipe material,

= 30,000,000 lb. sq. in. for steel,

= 16,000,000 lb. sq. in. for cast iron for usual pressures,

= 1,600,000 lb. sq. in. for Douglas fir (Oregon pine),

= 1,061,000 lb. sq. in. for redwood.

E_2 = E as modified by elasticity of pipe walls.

C = velocity of wave in water, pipe distention not considered.

C' = velocity of wave in water, pipe distention considered.

r = internal radius of pipe in inches.

g = 386.4 inch sec.

γ = 0.03604 lb. cu. in.

p = excess pressure in lb. per sq. in.

c = vel. of water (ft. per sec. or) in. per sec.

t = thickness of pipe-wall in inches.

T = time of closing valve, sec.

T_r = time for round trip of wave to reservoir and back.

R_d = wall thickness divided by internal diameter.

When pipe distention is not considered

(1) $$C = \sqrt{\frac{Eg}{\gamma}} = 4726 \text{ ft. per sec.}$$

(2) $$p = c\sqrt{\frac{E\gamma}{g}} = 63.3\ c \text{ (ft. per sec.)}$$

Considering the elasticity of the pipe-walls

(3) $$C' = \sqrt{\frac{E_2 g}{\gamma}} \text{ in which}$$

(4) $$E_2 = \frac{EE'\,t}{tE' + 2rE}$$ and the velocity of the wave

(5) $C' = 103.5\sqrt{E_2}$ in inches per sec. and

(6) $C' = 8.625\sqrt{E_2}$ ft. per sec.

(7) $p = \frac{cC'\gamma}{g}$ inch sec. units.

(8) $= 0.000093\ cC'$ inch sec. units.

(9) $= 0.0134\ cC'$ for c and C' in ft. per sec.

(10) When T is greater than T_r, pressure

$$p1 = \frac{p\,T_r}{T}$$

The following formulae have been deduced from the curves of the diagrams which were constructed from the above. In the diagrams the ratios of wall thickness to internal diameter are given as being more convenient than ratios involving the radius. The values of E_2 may be found, if desired, as the curves are equilateral hyperbolas, with the ratios R_d for abscissae and for ordinates the relation $\frac{E}{E_2} - 1$ referred to the asymptotes. The constant K in the equation

$$R_d\left(\frac{E}{E_2} - 1\right) = K$$

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varies inversely as the modulus of elasticity of the pipe material and has a value of $\frac{300,000}{E'}$, giving results as follows:

K for steel $= 0.01$
cast iron $= 0.02$
Douglas fir $= 0.1875$
redwood $= 0.2825$

From the above: $E_2 = \dfrac{E}{\dfrac{K}{R_d} + 1}$

For example, for steel pipe and $R_d = 0.008$.

$$E_2 = \frac{\dfrac{300,000}{0.01}}{\dfrac{0.008}{} + 1} = \frac{300,000}{2.25} = 133,333 \text{ lb. sq. in.}$$

The vertical scale of the diagram for steel and cast iron has been doubled, so that, in the example, the ordinate, which is equal to $\frac{K}{R_d}$ and has a value of 1.25, will measure 2.50 in. In the other diagram the values read direct. In other words, to obtain E_2 from the steel and cast iron diagram, for any value of R_d, divide 300,000 by half the corresponding ordinate plus one, and from the diagram for wood stave pipe divide 300,000 by the corresponding ordinate plus one.

It will be noticed in the formulae that the effect of pipe extension is treated as producing a virtual modification of the bulk modulus of water. The diagonals between the lines A-B and O-O are to permit the use of straight lines for water velocity. It follows also from the formulae given above, that the velocity of wave in a pipe of any material having a modulus of elasticity E',

$$(11) \qquad C' = \frac{4726}{\sqrt{\dfrac{300,000}{E' R_d} + 1}}$$

$$(12) \qquad C' = \frac{4726}{\sqrt{\dfrac{K}{R_d} + 1}} \text{ in ft. per sec.}$$

By inserting the value of C' from (12) in (9) and reducing,

$$(13) \qquad p = c \frac{63.3}{\sqrt{\dfrac{K}{R_d} + 1}}$$

with c expressed in ft. per sec. and p in lb. per sq. in.

From (11)

$$\frac{K}{R_d} + 1 = \frac{E}{E_2} \quad \text{therefore}$$

$$p = c \frac{63.3}{\sqrt{\dfrac{E}{E_2}}}$$

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Hydraulicking at Panama

By CHARLES S. HALEY*

THE Pacific division of the Panama canal, more properly called the southern than the western end, comprises that portion which lies south, or southwest, of the Culebra cut. The construction work at this division embraces the Pedro Miguel lock, in which ships from the Atlantic side are lowered from the level of the Gatun lake to that of the Miraflores lake, a vertical distance of 35 ft., the Miraflores locks, in which the remaining descent of 50 ft. is accomplished, and a section of some eight miles of sea-level canal extending to the Pacific ocean. The latter portion of the work consists chiefly of excavation under water, and is being accomplished by dredges of both the scoop and bucket-chain type, whose product is dumped into barges alongside and towed out into the ocean by tugs. On this work a dredge with two sets of buckets is employed, the smaller of which (shades of Natomas!) has a capacity of 54 cu. ft. To its credit it may be said that it is in operation nearly half the time, and in the shop the other half.

It is, however, of that portion of the canal from the Miraflores to the Pedro Miguel locks that I wish to treat chiefly. This work has been accomplished very largely by means of hydraulic giants, and the engineering problems involved have been solved in a very able manner. The ground in which the excavation was to be done consisted mostly of swamp and morass, which afforded just enough consistence to make it difficult to employ suction dredges, which were, however, used for a time in that portion where they were applicable. A hydraulic plant was installed, consisting of a large pumping plant that delivered water from the ocean at a pressure of 150 lb., corresponding to a head of 300 ft. This water was carried through 30 and 36-in. mains for two or three miles along the banks of the canal from the Pedro Miguel below the Miraflores. Several giants were installed, most of them using a 6-in. nozzle. Jamaicans are employed to attend to the actual pumping work, under the superintendence of nozzle-foremen, who are whites, and furnish the brains, energy, and profanity required to keep the somnolent 'British object, saire' from directing the stream against a piece of bedrock and watching it splash.

The washed-down débris was removed by a process which presents an individual set of problems. Centrifugal pumps were used at first, mounted on barges, but this plan was abandoned. The main difficulty was that the barges were floating on water which was susceptible, on account of seepage even after a dam had been thrown up, to the rise and fall of the tides. This resulted in the barges, laden with heavy motors and pumps, inevitably becoming stranded on partly submerged portions. Leaks followed as a natural consequence, which interfered with, where it did not destroy altogether their usefulness.

*Callao, Peru.

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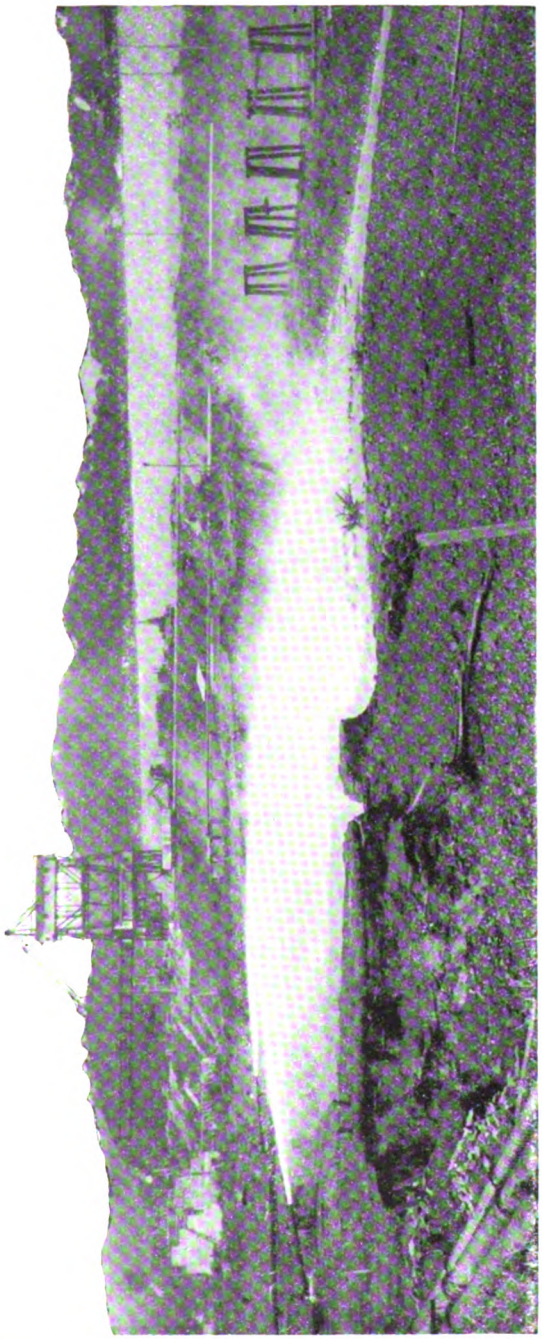
Therefore the pumps were placed on concrete foundations on terra firma wherever practicable. As the excavation progressed, this became easier to do, until now all the pumping stations are on dry land. This has led, however, to some peculiar situations. In one instance I saw a relay-pump in operation with about 45 ft. of suction pipe. The result was that the discharge



GIANTS AT WORK AT MIRAFLORES.

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end was running ahead of the intake, and a water-hammer was induced which threatened to lift the pump through the roof. A temporary relief from this state of affairs was obtained by boring a hole in the suction-end and permitting the pump to take air through a globe-valve and nipple. Of course this cut down efficiency, but nevertheless the pump was throwing a good stream and taking care of all that the giants brought to it.

A certain amount of carelessness in furnishing supplies, however, has resulted in impairing the efficiency of the giants to a great extent. I saw 12-in. pipe which had been laid for less than two months—flange pipe at that—spurting water at every joint, beneath the flanges. Although the pressure is rated at 150 lb., and the pumps are amply able to deliver water at that presure, I should judge, from the looks of the streams thrown, that the operating head is well under 200 ft. The material discharged by the pumps has been disposed of with excellent judgment. In the formation of Miraflores lake, it was necessary to build a long dam from the upper Miraflores lock, running northwest for the greater part of a mile, in order to take care of the flow of two or three streams. This dam has been built of earth, with a core of clay supplied by the centrifugal pumps. The dam is about a thousand feet wide at its base, of which about 600 ft. is made up of the hydraulic core, which, when it has dried, is impervious to water. In other places, whole swamps have been converted into dry land by the use of this discharged material. Most of the discharge pipe-lines appear to be about 20 in. diameter.

In connection with this work our friends, the 'British objects,' have figured in a rather disagreeable, but none the less necessary, form of service. The suction ends of the pumps frequently become clogged with roots, fish, etc. As a result, a force of Jamaicans is kept around each pump to dive through from 3 to 6 ft. of mud, and remove the obstructing material. When the pumps are running clear, however, they have nothing to do but lie around in the sun, and the catch of fish helps out the board bill. The greater part of this work has been accomplished: the chief work of the giants now is to clear off the bedrock so that the shovels can work effectively. A force of Star drills is kept at work on the exposed bedrock, where a good deal of excavation remains to be done, and the shovels will follow after. Some rather interesting work is at present being done with home-made hydraulic elevators. Although not very beautiful from a mechanical standpoint, they seem to do the work, and, after all, that is what they are there for. In short, the entire extent of the work which has been accomplished by hydraulic means on the canal goes to show, as does all the rest of it, that the 'Yank' can do pretty much everything that he starts out to do, and that on the Zone, as everywhere else, a man can feel a justifiable pride in the achievements of his countrymen.

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The Engineering Digest

Combustion of California Crude Oil*

By WILL M. GLASS

THE combustion recorder holds the same relation to furnace operation that the steam-engine indicator does to engine performance. Both instruments supply a record of what takes place within the apparatus to which they pertain.

Economy in the combustion of fuel is the most important question that confronts the modern engineer and the man who pays the bills. A few months ago, a certain chief engineer said to his subordinate engineers and firemen: "When you regulate your crude oil burner, watch the stack and do not allow the fires to smoke; for if they do the oil is wasted and you do not get perfect combustion."

The up-to-date chief engineer, when addressing his crew on this point, speaks thus: "Carry 12% or more CO_2 on your CO_2 recorder; keep your boilers free from soot and scale, and the boiler brickwork and settings free from air leaks; use as little air as possible for combustion, and see that the fire burns with a yellow color and that a dark brown vapor leaves the stacks." The chief tells his men this, for he knows that when the color disappears in the air about ten feet from the top of the stack, less oil is required to do the work.

Let us consider three classes among the many forms of oil-burning devices, so that we may gain an idea of the type of apparatus best adapted to secure economy in the combustion of California crude oil.

First, there is the front-shot burner and the furnace with air spaces between the fire-brick on the grates in front. This style throws a fan-shaped flame, which leaves the two front corners without any fire, and it also throws the flame upward in such concentrated form as to often cause horizontal tubular boilers to bag or blister; usually when there is considerable scale or mud on the crown-sheet. With a water-tube boiler, the front shot-burner, when forced, will concentrate the flame upon the tubes and is very likely to burn holes in them at points about 18 inches in front of the bridge-wall, particularly when there is a coating of scale, mud, or oil internally, and soot externally.

A second style of burner is the back-shot, which is placed at the bridge-wall; the air spaces being just in front of the bridge-wall. This style throws a fan-shaped flame toward the front, and when used with a water-tube boiler the flame has more room to expand and is claimed to be several per cent more effective than is the flame from a front shot-burner. The flame parallels the tubes, and although it may burn the tubes in the lower rows the danger is more remote than with the front shot-burner.

A third style of crude-oil burner and furnace is the invention of H. C. Ruggles. This apparatus is so constructed that the burner is situated in the centre of the furnace, with the air for combustion entering mainly in the same region, and also through openings along the sides and rear of the furnace; the latter to be used only in the case of very heavy firing. The doors to these extra air-ducts are placed alongside the ashpit doors. The flame from this burner spreads horizontally in the shape of an oval, completely covering the furnace grate. All of the air for combustion is compelled to pass up from beneath and to become thoroughly mixed with the flame. The flame is almost like that

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from a coal fire after a fresh charge of coal has been spread evenly and has burned to incandescence, and the flue-gases have taken on a dark brown color as they leave the stack.

It is claimed that tests made with the Ruggles burner have shown it to be 10% more efficient than other well known types. During a period of twenty-four years service with many corporations, I have used many different types of apparatus in the burning of California crude oil. My experience in this field leads me to the conclusion that for even distribution of the heat upon the tubes or shells of water-tube or fire-tube boilers, the Ruggles crude-oil burner and furnace stands in the lead of all others.

The Orsat apparatus is used for measuring the quantities of carbon dioxide (CO_2), oxygen (O), carbon monoxide (CO), and nitrogen (N) which are contained in the products of combustion. The nitrogen remains after the CO_2, O, and CO have been absorbed by the various chemicals which are used in the apparatus.

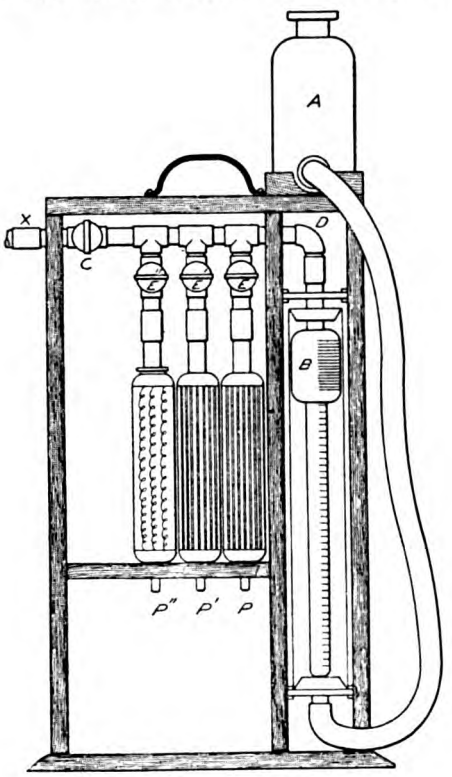

FIG. 1. ORSAT APPARATUS.

Fig. 1 shows an Orsat apparatus. *A* is the water-leveling bottle; *B* is the burette of 100 c.c. capacity; *C* is the cock for turning on or shutting off the sample of flue-gas. *D* is the connecting tube for the various tests; *X* is the tube that connects the apparatus with the ½ or ¾-in. pipe which is inserted in the back-pass of a water-tube boiler, or in the breeching, close to the stack, in the case of a horizontal fire-tube boiler.

E is the cock which opens the passage to the pipette *P*, which contains the potassium hydrate, or caustic potash, as it is usually called. This chemical is dissolved in water in the proportion of one part of potash to two parts of water by weight. The capacity of the solution to absorb CO_2 is in the ratio of 1 to 40.

E' is the cock which opens the passage to pipette *P'*, which contains the potassium pyrogallate for absorbing the O. This solution is made by dissolving 5 gm. of solidified pyrogallic acid in 100 c.c. of a caustic solution made by dissolving 120 gm. of caustic potash in 100 c.c. of water. One cubic centimetre of this solution will absorb 2 c.c. of oxygen.

E'' is the cock which opens the passage to pipette *P''*, in which the carbon monoxide is absorbed. This gas, however, must first be passed through *P* to remove the hydrochloric acid vapors.

The nitrogen which usually remains after the absorption of the CO_2, O, and CO, is passed to the burette *B* for measurement.

To test a sample of flue-gas for carbon dioxide, first fill the jacket with water, then open cock *C*, raise the leveling bottle *A*, and fill the burette *B* to the top with distilled water. Then shut off cock *C*, open cock *E*, raise the caustic potash to the mark beneath *E*, and close *E*. Again open cock *C* and raise the water in burette *B* to the top. Next clear the air from the gas-inlet pipe by using the bulb, and connect the pipe, at *X*, with the apparatus, after closing cock *C*.

Next open cock *C* and take 100 c.c. of gas into burette *B* by lowering the leveling bottle *A* to zero on the burette scale, and then close cock *C*. Then open cock *E* and raise the leveling bottle, thus forcing the gas to enter pipette *P*, which is V-shaped and filled with a large number of small glass tubes; the caustic solution here absorbs a part of the carbon dioxide.

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The remainder of the flue-gas is then returned to burette *B* by lowering the leveling bottle *A* until the caustic potash rises to the mark just beneath cock *E*. This cock is then closed and the percentage of CO_2 is read directly from the scale on burette *B*.

The leveling bottle *A* should be held, each time a test is made, so that the water-level will correspond with the level of the liquids in the burette or pipettes.

Fig. 2 shows the layout of the essential parts of a Uehling carbon dioxide machine. The chief elements of this apparatus are the

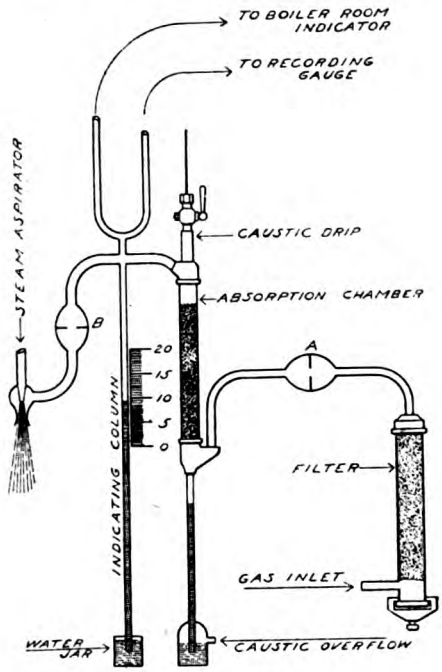

FIG. 2. UEHLING CO_2 MACHINE.

filter; the absorption chamber, which is fitted either with a valve for liquid caustic, or with a flake caustic cartridge; the two apertures *A* and *B*, and the steam aspirator.

The gas passes through the filter to aperture *A*, thence through the absorption chamber and aperture *B* to the aspirator, where it leaves the instrument along with the exhaust steam. The CO_2 is completely absorbed by the caustic solution between *A* and *B*. This reduces the volume and causes a change in the tension of the gas between the two apertures; the tension varying in consonance with the percentage of CO_2 absorbed from the gas, and thus adjusting the height of the water in the indicating column to correspond therewith. The variation of tension of the gas is also communicated to the recording gauge and boiler room indicator, both of which can be placed at a considerable distance from the machine.

Instruments of this class possess three principal advantages. First, the indication of the percentage of carbon dioxide is continuous. Second, the recording gauge can be placed in the superintendent's or chief engineer's office. Third, the indicator can be placed conveniently for observation by the fireman.

The following table was compiled, partly, by the manufacturers of the Uehling instrument. The figures are based upon an average heating value of 14,500 b.t.u. per pound of fuel, and also upon the assumption that 12 lb. of air per pound of fuel is required for perfect combustion.

Percentage of CO_2.	Pounds of air.	Percentage of fuel loss.
21	12	
20	12.6	
19	13.3	
18	14	
17	14.8	
16	15.7	10
15	16.8	12
14	18	13
13	19.4	14
12	21	15
11	22.9	16
10	25.2	18
9	28	20
8	31.5	23
7	36	26
6	42	30
5	50	35
4	63	45
3	84	60
2	126	
1	210	

A test with the Orsat apparatus, which I made in the municipal electric light plant at Pasadena, California, showed 9.2% of carbon dioxide. A subsequent test showed 14% of carbon dioxide, 3.2% of oxygen, and 0.2% of carbon monoxide. A recent test conducted in the plant of the Alexandria hotel, in Los Angeles, showed an average of 11.5% of carbon dioxide.

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Oil Fuel*

By J. J. KERMODE†

THE recent coal strike has done more to emphasize the value of liquid fuel than years of patient advocacy and toil. Many factories had to resort to liquid fuel to keep going, and in every case the boilers were expeditiously fitted for the use of liquid fuel without altering the furnaces as arranged for coal.

The amount of crude petroleum available at the time of the coal strike was limited, and stores soon became exhausted, and the prices rose to a point when no saving could be shown by the adoption of oil as a fuel, although it kept factories going when solid fuel was unobtainable. The lesson of the coal strike will not readily be forgotten, and the heads of many municipal electric-power stations have under consideration the advisability of being able to use liquid fuel should the necessity arise in the near future. It is my opinion that oil companies missed a great chance to establish oil firmly for certain industrial uses then; and raising the price of oil prevented its adoption in hundreds of cases which came under my notice.

The British Government has recently appointed a Royal Commission to go fully into the question of how far oil fuel can be of service to the Navy, and this has caused the general public to take a wider interest in oil fuel than heretofore, and the findings of the Commission will influence the attitude of the public to a large extent for or against a more general adoption of oil as a fuel.

In 1902 I advocated the use of the internal-combustion engine for certain special purposes on H.M. destroyers, but the suggestion was treated as rank heresy at the time; yet a few years after, the conservative attitude of the Admiralty authorities was completely changed and the appointment of a Royal Commission on oil fuel, whether burnt in the internal-combustion engine or in the furnaces of boilers, serves to indicate that the Admiralty is awakening to the importance of being abreast of the times, and to be up and doing with nearly, if not as much, progressiveness as is shown by private firms.

One of the romances of industry is the history of oil. Originally a natural curiosity, sold in ounces for special uses, it has now an annual world production in crude oil of probably more than 45,000,000 tons, an output that is increasing largely every year. Great as this output is, almost unlimited reserves of oil exist, both in the present known oil areas and in regions that are at the moment comparatively inaccessible. In its earlier development oil was used mainly as an illuminant. Today the future of oil lies in its extended use as fuel. Improvements in the method of treating crude oil have enabled the chemist and the engineer, in combination, to obtain from the natural product, not only illuminants, but benzines, naphtha, petrol, and lubricating oils, fuel oils, paraffin wax, and a host of valuable by-products. The search for the raw material of these valuable commercial products is being conducted with capital, enterprise, and the resources of science, in wise anticipation of the great future that is before oil in the transport and manufacturing world. Navies, railways, industries are all clamoring for oil. It is recognized that while the demand is making the supply, supply is increasing the demand.

Though the utility and economy of oil for fuel purposes generally have, in the past few years, been recognized, it was the announcement that the British Navy was adopting it that struck the popular imagination and directly induced the oil boom. Beginning with the experiments conducted for the Admiralty by me in 1902, the British naval authorities have been converted to the new policy. Briefly repeated, the superiority of oil over coal for battleships is the greater mobility of the vessel, smokelessness when it is essential that a warship should approach or slip away unobserved, rapid development of speed, the

*Abstract from *Petroleum World*, September 1912.

†Read at the Oil Congress, Olympia, London.

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'nursing' of the stokers, who would be absolutely exhausted in a long fight where coal is used: the keeping qualities of the oil fuel, and last, but not least, the extraordinary facility with which oil may be bunkered in mid-ocean in any weather by the use of a hose connection between the tank vessel and the warship. That the Admiralty is convinced on these points is sufficiently demonstrated by the fact that every battleship built in the last few years, now building, or merely projected, uses oil as auxiliary to coal. Of the bigger completed warships of the British Navy which have been equipped for auxiliary oil fuel may be mentioned the *Defence, Bellerophon, Temeraire, Vanguard, Invincible, Superb, Collingwood,* and others, all vessels of from 18,500 to 19,250 tons. The super-dreadnaughts of the future are also designed with the same purpose. Of destroyers, good types of the latest oil-fired vessels are the *Swift,* an ocean-going destroyer which can steam from 1500 to 1700 miles without re-oiling, and the fastest warship in the world; the *Nubian, Crusader, Zulu, Maori, Viking,* etc. All these vessels use the Kermode systems of oil-firing.

Apart from the fighting oil-fired steamers, however, oil is coming for the ordinary mercantile marine. Probably for a very long time coal and oil will both be used, the two systems being alternative on each vessel, as in the case of warships. The fact that from Port Said to Yokohama it is now possible to re-fuel a ship with oil is an inducement to eastward-bound shipping to adopt the cheaper and cleaner method. The Empress boats of the Canadian Pacific Railway, it has been announced, are to be oil-fired, the system having been tried on the Princess coasting liners with a saving of 40 to 60% over Vancouver Island coal. My firm has in hand projects for considerably over 250,000 hp. for warships and mercantile ships, to say nothing of the conversion of a foreign railway from coal to oil. Successful installations have also been completed for the Argentine Government. This is all evidence of the coming of oil fuel, not only for steamships, but for all sorts of industrial purposes. It can be said, too, that several companies, British and foreign transatlantic companies, have this question under consideration. The value of oil fuel for railways has already been demonstrated. Traveling to Galician oilfields, for instance, from England by way of Berlin, the coal-burning locomotive is exchanged at Cracow for one burning oil. The advantage is obvious in more economy, less smoke, and less dirt. Oil-fuel locomotives run continuously at 100 kilometres per hour. On the Rumanian railways oil is now the chief fuel. On March 31 last year, out of 648 railway engines in the possession of the railway administration, 549 were provided with apparatus for liquid fuel, and only 89 were using wood and coal. This year 80 more engines were converted. In 1888 the value of fuel used was 21,154 francs for liquid fuel and 1,386,899 francs for wood and coal. In the year 1908-9 the value of liquid fuel was 4,191,003 francs, and of wood and coal only 1,951,292 francs. There are many outfits also on the South American railways.

These railways are near the oilfields, of course, but the coming facilities for ready distribution of oil everywhere will bring oil to the door of every industry. The steamer for carrying oil in bulk has already arrived, and projects are being entertained for dispensing with heavy railway freights by feeding large industrial centres with pipe-lines from the coast, as is done already by the Liverpool Gas Co., which uses crude petroleum for enriching the gas, and sends the stuff from oil ships at the Garston docks by pipe-line to the gasworks. The future of oil for the preservation of roads has, to use an 'Irishism,' already come, and examples of the utility of oil fuel for industries might be multiplied, suggesting, at all events, one way of meeting foreign competition. Certain it is that a London glass firm which felt the pinch of foreign rivalry converted its plant to the oil fuel system, and it is now able to snap its fingers at Belgian and German rivals. These is, too, a humanitarian side, as well as an economic one, of the question. Just as the exhausting conditions under which the stokers have hitherto worked on board ship are made comparatively comfortable, it is claimed for oil fuel that its cheapness will make possible for relief from white slavery of such workmen as the chainmakers and other laborers whose toil is heavy, degrading, and mechanical.

From every point of view the boom in oil, the vast resources of fuel that are being tapped, will without a possible doubt

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come to the world as an almost unqualified blessing.

The combustion is perfect; there is neither smell nor smoke, no dust, no waste of oil fuel on starting or on shutting down, and no soot or ashes to remove. High calorific value: bulk for bulk, the greater part of the above-named fuels will give off during combustion nearly twice the number of heat units obtainable from average coal; the cost of transit will, therefore, be about half that of coal, and the space occupied will be less. If the fuel is stored in suitable tanks, there is absolutely no risk from fire or explosion. Cleanliness in handling, simplicity of construction, ease of management, perfect and instant control of fires, as they can be shut down or started off at a moment's notice, and, unlike a coal fire, no fuel is expended and no heat is lost when the oil fuel supply is stopped. It is sometimes necessary to draw coal and wood fires when there is a temporary stoppage in the course of working; this causes a risk of fire (if in a factory) and also proves objectionable on account of the fumes or dust.

In the case of steamships the advantages may be enumerated thus:

Steady steam, fires never dirty, no fires to clean, consequently no tube cleaning. From the effect of dirty fires and boiler tubes fouled with soot and ashes, quite 12½% of steam is lost upon a voyage between points seven days apart. The loss of speed is, therefore, considerable. Reduction of bunker space to about five-eighths of that required for coal. Reduction in the number of hands in the fireroom department, as the apparatus is automatic in action, and one man can attend to several boilers.

Those portions of the ship which are now useless for coal bunker purposes, through their narrowness or position, are always available for the storage of oil fuel. In this way the double bottom can be used, and the trim of the ship can be preserved by the admission of sea-water to the emptied oil tank.

There need be no such thing as a list to port or starboard through being obliged to use fuel out of one bunker more than another. A steam pump will readily remove oil fuel from port or starboard, or vice versa, when the same expedient is impossible with coal.

The bunkering of the largest ship can be effected cleanly and silently in a few hours, as hundreds of tons of fuel can be pumped into the bunkers in an hour. There is no smoke even when steaming at full speed, and the fires can be checked instantly if the engines are slowed, and quickened again as instantly to meet the quicker speed of the engine. All boilers of whatever type are available for the use of liquid fuel without any modification of the arrangement of the furnace as used for coal, except in some special cases.

In the case of industrial process furnaces, oil fuel will sometimes do three times the amount of work of coal. Much depends upon the design of furnace, and too much attention cannot be given to this important matter.

The important improvements which have been effected in the fire brigades of some of the leading cities of this country and also abroad are owing to the adoption of liquid fuel, and the Liverpool, London, and numerous other fire brigades use the Kermode liquid fuel system, and liquid fuel has rendered it possible to have self-propelled steam motor fire-engines of great power, speed, and efficiency.

The difficult question of bunkering a warship at sea is got over at once if oil fuel is substituted for coal. The varying demands of an electric-power station are instantly met by its use; cartage of coal, soot, and ashes, the inevitable dust associated with the use of coal, are all got rid of, and the smokestack is innocent of smoke. These considerations are important factors in the case of our largest cities.

Liquid fuel has been used for locomotives for a great length of time, and there is no reason why it should not be adopted for the great variety of steam craft which ply on our inland canals, and for the coastwise steam lighterage service. So infinite are the uses to which liquid fuel may be put, and in very many instances the economies can be effected are so striking when every aspect of the question is studied, that the relative value of oil fuel versus coal cannot be decided hastily by a mere comparison of the relative prices of the two fuels. The relative cost of fuel alone is the chief consideration of most business men, who overlook the important factor of cheaper production and more of it, and time saved. To the worker it means, in most cases, better wages owing

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to greater output of work; it also means healthier conditions of employment.

In foundry practice the use of oil fuel will reduce the time taken to dry large cores to a third of the time which it takes to do the same work with coal or coke. Thus there is not merely the time saved on the operation to be considered, but the all-important factor of the speed with which molds can be ready, castings completed, and goods despatched, far outweighs every consideration of the cost of fuel. On the assumption that a foundry floor is available one and a half times as often owing to the employment of liquid fuel for the purpose mentioned, the cost of fuel hardly counts, as it is overshadowed by the many advantages gained.

There is not a process where heat is required where the operation of heating cannot be more rapidly accomplished with oil fuel than with coal; and the absolute control over temperature, absence of smoke, smell, soot and clinker are points in favor of liquid fuel and for the healthier conditions of working which its employment makes for.

Oil fuel can be used for the most delicate operations. Tea drying in Ceylon and India is done by its aid, and experience shows that the natives find no difficulty in using the appliances devised for the purpose. The combustion of fuel is so perfect that there is not the slightest odor in the factory.

In many of the metal trades, such as the bedstead and bicycle tube factories, the number of sheets of metal spoiled in the rolls owing to the plates being imperfectly heated is considerable. Coal fires are very irregular, despite careful attention, but the automatic oil fires would ensure that every heat was uniform, and the percentage of wasters would be reduced to a trifling amount.

In the reduction of certain ores, absolute control of temperature is the great factor, as every metallurgist knows, and oil fuel could be used here with advantage.

Many ores that are poor, and if treated in a coal-fired furnace would scarcely pay for the fuel and labor expended, might, if treated with liquid fuel as a substitute for coal, give a satisfactory return.

In the art pottery business many valuable pieces are ruined by imperfect firing where coal or coke is used, and both time and art is expended upon material which is doomed to be condemned, when probably modification of design of oven and the adoption of oil fuel would considerably diminish the number of faulty pieces of ware.

So far none of the great Atlantic liners has adopted liquid fuel. This is apparently due to the fact that the vessels have been built in the coal age, and the necessary rearrangement of the bunkers has been regarded as a difficulty, coupled with the old-time prejudice of shipowners against oil. The latest liners, however, have been so constructed that they can be adapted for the use of oil without much trouble. The day cannot be far distant when these mercantile leviathans will follow in the course of the Navy, for although our proximity to the great coalfields gives us a supply of coal at a much cheaper rate than oil, the smaller quantity of liquid fuel required, the reduction of the stokehold crew, and the extra space available for passengers and cargo, combined with rapidity of bunkering, superior speed, and greater cleanliness provide a very handsome turn of the balance in favor of oil. The *Mauretania* and *Lusitania* afford striking examples of what might be done in the direction indicated. On an average, to maintain a speed of 25 knots, 5500 tons of coal are consumed on the voyage between Liverpool and New York by one of these mammoth liners, or 11,000 tons for the round trip. Some 3300 tons of oil fuel—which could be stored, if necessary, in the double bottom of the vessel, thereby leaving the coal bunkers available for cargo—would by automatic stoking do even more work than 5500 tons of coal. Calculating the daily consumption of 600 tons of coal now used every 24 hours, representing about 2000 tons less fuel on a five days' trip, land to land run, or 4000 tons less out and home. The utilizing of the vacant space for merchandise at, say, £1 per ton, would mean a very substantial increase of income. Of the 312 firemen and coal trimmers now employed on each ship, 285 might be dispensed with and occupation found for them under healthier conditions ashore, in handling the extra cargo that would be carried. Twenty-seven greasers would be able to attend to the oil-burners and regulate the water feed of the boilers. At least 200 third-class passengers at £5 per head, of which 50% would be profit, would be berthed by altering the accommo-

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dation reserved for the 285 firemen and trimmers. Even with coal at 18s. 6d. per ton, as against oil at $7 per ton on the eastward voyage, and 45s. per ton on the westward passage, the increased earning capacity of such vessels under oil would be over £10,000 for the round voyage out and home. A full supply of oil could be taken on board in three hours compared with twenty hours for coaling. With regard to the factors which determine speed, it must be remembered that the *Mauretania* and the *Lusitania* are each fitted with 192 furnaces in order to produce 68,000 indicated horse-power. On the assumption that 32 fires are cleaned every watch, 10,000 i.h.p. is lost every four hours through burning down and cleaning—an unnecessary operation under oil fuel. Moreover, irregular coal stoking is responsible in most cases for 10% loss of steam throughout a voyage, while lowered efficiency of the boilers is involved by the accumulation of soot in tubes. Experience on other ships justifies the belief that the use of oil fuel would reduce the voyage between Queenstown and New York by eight hours. We might look, therefore, to another great era of Atlantic records.

The question of oil supply is, therefore, a prime necessity of any general scheme for the adoption of the liquid fuel system, and this is practically determined by the discovery of the oilfields throughout a large area. The provision of oil fuel depots along the coast and ocean highways of the world's commerce has become an urgent necessity. On our eastern trade route it is cheaper, even in the initial cost, apart from the saving in operation, to use liquid fuel than coal, anywhere east of Port Said. There are oil depots at Port Said, Suez, Aden, Colombo, and various eastern ports, including Kurrachee, Bombay, and Calcutta. Oil-driven mail and cargo steamers going west from San Francisco can take oil fuel at Borneo or Java at the end of their journey, and on reaching home they have the Californian oilfields at hand, while ships going north and south can bunker in California or Peru. The Atlantic seaboard is not well served with oil fuel at the present time, but pipe-lines are being constructed to deliver Californian oil to the Atlantic coast. Pipe-lines are already in existence from the Texas oilfields to Port Arthur in the Gulf of Mexico. Oil has been discovered in many places in Mexico recently, and Trinidad, Colombia, Venezuela, the Argentine, the west coast of Africa, and South Africa may be regarded as future sources of supply. If there is sufficient enterprise to develop the oil resources of these several countries on the Atlantic seaboard, depots can be established in every ocean for the use of merchant steamers and warships.

The industries in which oil fuel is already playing an important part are many. When applied to industrial process furnaces the value of oil is out of all proportion to the relative calorific value it bears to coal. Although the average calorific value is 19,500 b.t.u. for oil, as against 14,500 for the best Welsh coal, or a little more than 30%, oil fuel performs thrice the amount of work of coal. This fact has to be taken into account when comparing the market prices of the two commodities. In the glass trade, liquid fuel has produced wonderful results, where it has been tried, not only in the greater quantity and better quality of articles manufactured, but in the economy of working and the higher wages which the employees have been able to earn under easier and healthier conditions than are possible with coal or coke furnaces—factors of no slight significance in the severe fights against foreign competition. As against the old method of melting white flint glass in coal or coke crucibles, glass is now being melted in open tank furnaces with oil fuel, and although the flame is in actual contact with the metal, thereby reducing the amount of fuel necessary, no discoloration or deterioration of the glass ensues. In the art pottery business many valuable pieces of glass and china are ruined by imperfect firing where coal or coke is used, and it is claimed that oil fuel would considerably diminish the output of faulty ware.

The rivet trade, for which the Belgians are making a bold bid, is benefiting very materially from the introduction of liquid fuel, which is bringing upon the production of rivets a force powerful enough to resist the Belgian attack. Tea drying in Ceylon and India, as already referred to, is now done by the Kermode oil fuel apparatus, odorless and smokeless, and the temperature of the heated air used for drying the leaves does not vary more than 3°F. in a working day of ten hours. As a matter of fact the industrial pursuits to which oil fuel

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has been applied are innumerable. Suffice it to say that, besides those occupations already mentioned, it is at work in the melting of brass and other materials, forging, welding, and annealing furnaces, core drying, ore reducing, refuse destructors, electric power stations as an auxiliary to coal for meeting a sudden demand for extra power, factory boilers, cloth-singeing machines, and in gas works for using the by-product (gas tar). The field of operations is steadily and surely extending. There are many industries in this country panting with exhaustion from disabilities which an abundant supply of oil fuel at a reasonable price would remedy, and if oil companies would provide facilities for the transportation of cheap oils, possibly by a system of pipe-lines between the coast depots and the chief industrial centres as is done by water companies, the whole face of industrial England would undergo a change for the better.

Traffic by road and rail, as well as by sea, is being propelled more and more by oil. With liquid fuel Great Eastern engines have hauled trains weighing 225 tons on a consumption of 17.6 lb. of oil per mile, against 34 lb. of coal; while on the Japanese and Chilean railways a similar mode of propulsion is in vogue. The Egyptian railways are adapting their locomotives for oil fuels, which can be delivered at Khartoum at a price equivalent to coal at 30s. per ton, whereas coal there costs £5 per ton. There is an increasing use of Californian oil for driving locomotives on the big Western railways of America.

Several oil companies have laid down depots along the coast, and ships can bunker with oil fuel at London, Avonmouth, Barrow-in-Furness, Manchester, Belfast, Foynes (near Limerick), Birkenhead, Grangemouth, South Shields, Sunderland, Hull, and other ports.

The oil fuel is free of sulphur, and an average analysis shows:

	%
Carbon	84.4
Hydrogen	11.5
Oxygen	3.7

and a calorific value of 19,160 b.t.u. and a theoretical evaporative power of 19.8 from and at 212° Fahrenheit.

Oil fuel which has a theoretical calorific value of 19,320 b.t.u. is capable of evaporating 20 lb. of water from and at 212°F. (theoretically) for every pound of oil consumed, and if the air-jet system is used, from 15.6 to 16.6 lb. of water can be evaporated per pound of oil consumed under practical working conditions. That is to say, from 78 to 83% of the theoretical calorific value of the oil fuel is recovered for useful work.

The pressure jet system will recover from 75 to 80% of the theoretical calorific value of the fuel used, or less than 1 lb. of the oil fuel will produce 1 hp. in actual practice. That is to say, with oil fuel 19,320 b.t.u. the evaporation per pound of oil consumed would be 15 lb. of water or more. The steam-jet system will recover from 68 to 74% of the calorific value of the fuel used, or 1 lb. of oil will evaporate from 14.6 to 15 lb. of water. The average steam boiler using the best Welsh coal of a calorific value of 14,500 b.t.u. will only evaporate 9 lb. of water per pound of coal from and at 212° Fahrenheit.

Reinforced Concrete Telegraph Poles*

By GEORGE GIBBS

AMONG the facilities required on the New York Terminal division of the Pennsylvania railroad was the railroad company's telephone and telegraph service. The line for this purpose forms an extension of the New York-Philadelphia main line from its point of intersection with the Terminal Division at the east side of the Passaic river near Newark, New Jersey, and consists of a pole line along the right-of-way across a continuous five-mile stretch of semi-tidal swamp-land known as the 'Hackensack Meadows,' to the tunnel portal at Bergen hill, the Hackensack river being crossed midway of the section. The ground surface is covered with a heavy growth of reeds, and

*Abstract from *Portland Cement*, October 1912.

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the top stratum is a peaty bog from 8 to 15 ft. deep, underlain with varying strata of clay, fine sand, and mixed sand and clay for very considerable depths. It will be seen, therefore, that the problem was to provide a design of pole which would not only be strong in itself, but which could be set in a stable foundation in a soft and uncertain ground. It was desired to make the line entirely secure against interruption by severe storms or by fires in the swamp reeds. It appeared, under these conditions, that the ordinary type of wooden pole would not be wholly satisfactory, either as regards strength for such heavy service, or safety as regards the frequent meadow fires.

The use of reinforced concrete poles for the purpose appealed to us, but very little reliable data about either the cost or service from such design was obtainable. In Europe I had observed the quite extensive use of concrete poles, chiefly for electric transmission purposes, but details of their construction were not at hand. These poles are frequently of structural steel covered with a protective coating of concrete, and sometimes are of wood encased in concrete, and much ingenuity has been expended in devising special forms of composite poles, but with what practical success it is difficult yet to say.

The desirability, however, of securing a strong fireproof line across this section of our road was so great that I undertook to design a simple form of reinforced concrete pole, which could be manufactured on or near the work and at a cost which would not be prohibitive. Without previous data to go upon, the design evolved is somewhat experimental, and probably the notes here given will not be of very great assistance in fixing a precedent for an ordinary telegraph pole, as our conditions called for heavier construction than usually required for such lines. The data, however, are given for what they are worth, as indicating a heavy and difficult piece of construction for special problem.

Two hundred and two poles were required, spaced from 70 to 135 ft. apart, with an average standard spacing of 120 ft., the variations in span being due to numerous railway and highway crossings. The height of the top of poles above the ground also varies for the local conditions from 25 to 50 ft., and the total length of poles from 35 to 65 ft. The loading called for an ultimate capacity of 60 open telegraph wires and two 40-pair telephone cables, and one signal control cable. The open wires are of copper, No. 7 and 8, B. & S. gauge, and the cables No. 13 and 16 B. & S. gauge insulated wires, with a lead covering. The cables are carried by steel messenger wires. The weight of the wires and cables is 10½ lb. per running foot, giving a total loading for the average span of 1268 lb. per pole, or, including cross-arms, insulators, brackets, and fittings, 1500 lb. per pole. In addition to this static vertical loading, emergency conditions were assumed of an extra loading of ½ in. of ice on the wires and a wind pressure of 8 lb. per square foot on wires and 13 lb. per square foot on the poles. The stresses under these conditions are not to exceed the elastic limits of the wires and of the carrying structures. These assumptions are equivalent to a vertical loading of 7600 lb. per pole and a horizontal force of 4000 lb. exerted one foot below the pole top. The normal sag of the wires at 60°F. temperature is 4½ in., and a normal tension of 273 lb. for No. 8 wires and 130 lb. for No. 9. The maximum hot sag at 130°F. is 11 in.; the tension in the wires under maximum wind-pressure with the ice loading and at 20°F., is 702 lb. and 470 lb., respectively, for the two sizes of wires.

The design adopted is that of a tapering smooth-surface, reinforced concrete pole, square in cross-section, with chamfered corners and having a taper of ½ in. in 5 ft. The concrete is of 1½:2:4 mixture, assumed to have an ultimate strength in compression of 2000 lb. per square inch. The reinforcement is composed of mechanical bond bars tied into a square skeleton frame, and in the complete pole this reinforcement is covered by a 1-in. minimum thickness of concrete.

In order to manufacture the poles economically, a yard was established adjacent to the right-of-way and with sidetrack connections for delivery of materials. The ground was leveled and set with stringer pieces, 3 ft. apart, of old wooden car sills, so as to furnish a convenient surface upon which to erect timber forms. This yard permitted of the simultaneous manufacture of 6 poles and the storing in place of 90 poles during the period of seasoning. In the process of manufacture the skeleton reinforcement is

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first made up, the twisted steel mechanical bond bars being tied together to form a square skeleton frame; this frame is then suspended at the proper height above the ground and the sectional wooden frames put in position around it. The concrete mixture is then poured in and carefully tamped. In this way 6 poles were made per day and were left in place at least 16 days to season.

After a number of experiments it was found best to set the poles in pits excavated in the marshy stratum. These pits were generally about 9 ft. square and 5 ft. deep, and a timber grillage was placed around the base of each pole, and about 5 ft. below the top of the ground. This grillage consisted of 6 track cross-ties bolted together and to the pole, and partly planked over by 3-in. rough lumber. The pole, which projected below the grillage and was pointed at the butt, was jetted down by compressed air into the sandy layer, so that the grillage would rest at the bottom of the pit. The pits were then backfilled with rock and clay. Poles on curves are cross-guyed, and the terminal and railway crossing poles are head-guyed with steel cables.

In order to determine the stability of the foundations, as above described, as well as the transverse strength of the pole itself, a test was made of a 55-ft. pole set in a 13-ft. deep foundation. The test consisted in applying a horizontal pull 39.5 ft. from the ground. The breaking load was 4360 lb., and the point of fracture 20 ft. from the ground, at the top of the 32-ft. reinforcement bars. The foundation itself was found to be amply secure.

The actual cost of labor and material for manufacture of these poles, reduced to a unit cost for an average length pole of 40 ft., weighing 7600 lb., was as follows:

Forms—Labor and material	$19.00
Concrete—Labor and material	26.50
Reinforcement—Labor and material	32.00
Total per pole	$77.50

The above does not include cost of preparing site, engineering, etc., and is for the bare poles (without fittings or foundation timbers). To obtain the cost of the poles erected, there must be added the cost of loading, distribution, foundations and setting, cross-arms, and fittings, but these items were special to the particular location and would be of little use as a matter of general information. It might be stated, however, that the cost of handling and erecting these heavy poles was considerably more than would be the case for wooden poles; furthermore, care must be taken in loading and unloading them, and special appliances are required for their erection.

In the special case in question it was figured that the cost of the line erected complete was not greatly in excess of that of an equally stable wooden pole line, as, in order to meet such a condition, it would have been necessary to employ 'H' frame poles and set them in equally expensive foundation pits. In the case of this line it is interesting to note that the foundations and setting cost considerably more than the poles themselves.

To sum up, it may be said that for the particular case of this heavy line having very difficult foundation conditions, the use of a reinforced concrete pole resulted in a durable, safe, and neat-appearing construction at little additional cost to that of a wooden pole line inferior in all these respects. For the lighter class of telegraph lines, however, I would anticipate that concrete poles would cost more than wooden pole construction as ordinarily designed and erected.

L. V. Morris, chief engineer, Jamaica Improvement of the Long Island Railroad Co., has lately designed and manufactured a number of reinforced concrete piles to be used as station platform shelter supports. These piles are 28 ft. in length, and probably represent fairly well a telegraph pole of ordinary dimensions and strength. I therefore give, with Mr. Savage's permission, some information regarding them, as a matter of general interest, and for comparison with the heavy poles previously described. These piles are 28 ft. long, of hexagonal cross-section, tapering from 16 in. at the butt to 8 in. at the top. The reinforcement consists of eight ½-in. square twisted steel rods with a hooping of No. 7 wire wound on spirally, the ½-in. rods being attached to a tapered mandrel. At various points the hooping and the rods are wired together to secure the frame and prevent distortion. The piles contain slightly under 1 cu. yd. of concrete and weigh about 3700 lb., or an average weight of 132 lb. per foot. This compares with 190 lb. per foot

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for the Terminal Division telegraph poles. One of these piles was recently driven to a depth of about one-half its length and could not be driven further, although a thousand blows of a steam-hammer were delivered at the head; no appreciable effect resulted from this rough treatment and their usefulness was not impaired in any way.

Cost Data on 48-Inch Continuous Wood-Stave Pipe-Line*

By G. L. WATSON†

THE following cost data refer to a 48-in. continuous wood-stave water pipe line recently installed between Absecon station and Atlantic City. In 1882 a single 12-in. cast-iron main was the only connecting link between the pumping station on the mainland and Atlantic City, six miles distant. Later this was augmented by a 20-in. cast-iron pipe, and in 1910 an additional line of 30-in. riveted steel pipe was laid. Finally, in 1908, plans were formulated for building an additional 48-in. pipe. By the increase of the size of these pipes we may trace the growth of the resort, which has been most rapid, especially in the latter years.

It is almost impossible to attempt to describe the marshland that lies between the mainland and the island upon which are the cities of Atlantic, Ventnor, Margate, and Longport; but in general it may be described as a crust 14 to 18 in. thick composed of decayed vegetable matter, roots, and marsh grass, with some black mud, the whole of which is not compact, but honeycombed like a sponge. Beneath this is slimy black material containing fully 60% of water, consisting of sand and decomposed vegetation of various kinds, submerged at high tide. This material extends to a depth of over 90 ft. It seems that the top layer or marsh simply floats upon it, which conclusion can be borne out by digging a ditch, say 3 ft. wide and 2 ft. deep. This ditch, unless shored, will gradually close up and the ground soon resumes its original position. Or, if a line of stakes with 100-ft. stations is set with a transit, a week hence some of them appear to be as much as 3 ft. out of line. In fact, after careful observation, I reached the conclusion that there is a constant movement of the entire crust of the meadow.

Upon this floating morass the new pipe-line was to be constructed. Previous to this time the lines that were already laid had given trouble from one cause or another. The steel pipe was a failure owing to its rapid deterioration, and the cost of 48-in. iron pipe would be prohibitive owing to its having to be carried on double pile bents on 8-ft. centres, with piles no less than 60 ft. long. Therefore, it was decided to use continuous wood stave pipe.

Staves, $47.17 per M f.o.b. cars job.
Bands, $2.20 per 100 lb. f.o.b. cars job.
Saddles, $3.50 per 100 lb. f.o.b. cars job.
Clips, $3.50 per 100 lb. f.o.b. cars job.

Staves

Unloading from cars and hauling to job 2 miles	$1.00
Sorting into sections and unloading	5.00
Loading on larries (teams $5 per day, 10 hr.)	2.10
Delivering in sections along r.o.w.	1.05
Percentage of cost of track and laying 30-lb. rails	0.15
Supervision	2.30
Total labor cost along ditch	$11.60
Cost of lumber	47.17
Cost per M ft. b.m.	$58.77

Bands

Unloading from cars at Atlantic City, giving second coating of asphaltum as called for by specifications, reloading and shipping to Absecon, N. J., per 100 lb.	$0.10
Unloading from cars and haul to job	0.035
Rehandling in yard	0.015
Third coating in troughs (laborers at $2 per 10 hr.)	0.20
Loading on cars	0.02

*Abstract from *Jour.* Am. Soc. Engineering Contractors, September 1912.
†Consulting Engineer, Philadelphia, Pennsylvania.

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Delivering along r.o.w	0.22
Percentage of cost of track-laying	0.005
Supervision	0.015
Labor cost per 100 lb	$0.61
Band cost per 100 lb	2.20
Total cost per 100 lb	$2.81

SADDLES

Unloading from cars at Atlantic City, giving second coating of asphaltum, reloading and shipping to Absecon, N. J.	$0.05
Unloading cars and hauling to job	0.035
Rehandling in yard	0.015
Third coating in trough	0.10
Delivery along r.o.w	0.22
Loading on cars	0.01
Percentage of cost of track-laying	0.005
Supervision	0.015
Labor cost per 100 lb	$0.45
Saddle cost per 100 lb	3.50
Total cost per 100 lb	$3.95

CLIPS

Cost per 100 lb. in kegs delivered along the line of work	$3.68

TRENCHING

Cutting trench 2½ ft. deep, 6 ft. wide, by Parsons trenching machine, trench filled with water, machine carried on heavy 4 by 12-in. planks, 12 ft. long, laid cross-wise of trench, with 4 by 6-in. planks, 24 ft. long, laid on top for traction wheels to rest on, coal ($5 per ton) carried to machine by men in 50-lb. sacks across marsh, water rolled in barrels across marsh one-half mile to machine—cost per linear foot	$0.20
Trenching by hand, cutting ditch to 8-ft. width, trimming bottom and sides, men in ditch standing on movable platform which was dragged with them. All spoil thrown one side only	0.09
Backfilling pipe, using material excavated from trench and placing same over pipe, per linear foot	0.09

COST OF BUILDING PIPE

Actual cost of building pipe in meadow exclusive of foundation, of repainting or surplus embankment, not called for by original specifications.

29 ft. b.m. at $0.05877	$1.704
80 lb. bands at $0.0281	2.248
10 lb. saddles at $0.0395	0.395
1½ lb. clips at $0.0368	0.05
Total material per linear foot of pipe	$4.397
Machine trenching	0.20
Hand trenching	0.09
Pumping	0.10
Laying pipe	0.13
Banding	0.11
Cinching	0.42
Spacing	0.103
Painting	0.05
Backfilling	0.09
General supervision	0.14
Tools	0.10
General expense	0.22
Total cost per linear foot	$6.150

Actual cost of building in boulevard, trench 8 ft. wide, 7 ft. deep, running sand, water 18 in. below surface, close sheeting, no allowance made for sheeting lumber which was afterward used in fenders.

Total cost materials	$4.397
Excavation at $0.31	0.63
Sheeting 16 sq. ft. at $0.023	0.368
Pumping	0.16
Laying pipe	0.22
Banding	0.13
Cinching	0.48
Spacing	0.12
Painting	0.055
Backfilling	0.15
Removing sheeting	0.24
General supervision	0.14
Tools	0.10
General expense	0.22
Total cost per linear foot	$7.41

Actual cost of building pipe along side of Meadow Boulevard road, extra was paid for removal of sloping shoulder, trench 8 ft. wide, 3 ft. deep, in moist sand.

Total cost, materials	$4.397
Excavation	0.07
Laying pipe	0.09
Banding	0.07
Cinching	0.383
Spacing	0.09
Painting	0.04
Backfilling	0.08
General supervision	0.14

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Tools	0.10
General expense	0.22
Total cost per linear foot	$5.680

Actual cost of building pipe on trestle over thoroughfare crossings three hours per tide.

Total cost, materials	$4.397
Temporary working platforms	0.20
Additional cost, lighters and scows	0.10
Laying pipe	0.13
Banding	0.10
Cinching	0.40
Spacing	0.10
Painting	0.053
Blocking and temporary wedges	0.12
General supervision	0.14
Tools	0.10
General expense	0.22
Total cost per linear foot	$6.06

Embankment

Cost of constructing an embankment 18 in. thick on top and 2 ft. thick on sides over pipe, to a width of 6 ft. at the top, 12 ft. at meadow-level, all material taken from meadow, 16 ft. from centre of pipe, trench to be cut even and graded, to act as drain for water in pipe trench.

1 foreman at $4	$4.00
1 sub-foreman at $2.50	2.50
15 laborers at $1.75	26.25
1 water-boy at $1	1.00
Percentage of cost of tools for sharpening	1.00
150 ft. per day	$34.75
Cost per linear foot	0.231

Timber Foundation—Extra Work

Timber per 1000 ft. f.o.b. Atlantic City	$26.50
Hauling to job, 6 miles, one trip per day	5.00
Unloading to cars and pushing along line	10.00
Unloading from cars, sawing, and assembling along ditch	1.50
Placing in position and spiking	5.00
Supervision	2.00
Cost per M	$50.00
Cost per foot of pipe	0.45

Erection of Laborers' Quarters, Etc.

Cost based on 25,500 linear feet of pipe, for building and erecting one bunk-house of 150 men capacity, one house of 100 capacity, one mess-house, one store-house, etc.

One store-house, and one foremen's quarters, no lumber taken into account as the houses were torn down and the lumber used in the pipe foundation when a change of base was made.

Cost per foot of pipe	$0.18

Fender Construction

The operating costs per day of the pile driving crew were as follows. This crew was paid 12 hours for a day's work, but worked only 8 hours, 4 hours on each rising tide.

1 foreman at $0.80	$9.60
1 engineman at $0.30	3.60
1 topman at $0.225	2.70
2 deck hands at $0.20	4.80
2 set-men at $0.20	4.80
1 boatman at $0.20	2.40
Labor per day	$27.90
Coal	2.00
Scow rental	8.00
Total cost per day	$37.90
8 piles for 2 tides, cost per pile	4.74
Cost for foot of pile driven	0.157

This cost is high, but it must be borne in mind that the tide rose and fell so quickly that only 4 piles could be driven in one tide, while with deep water 25 piles could and have been placed under like conditions.

Fenders

One 30-ft. pile every 5 feet.

Stringers, two 2 by 12-in. lower, two 2 by 12-in. upper notched in piles, and bolted with 1 by 8-in. bolts with O. G. washers. Uprights, 2 by 12-in., 6 ft. long, 2 bolts, one in upper and one in lower stringer, 4 O. G. ¾-in. washers. Fenders painted with bituminous paint.

Based on 10 linear feet of fender.

60 ft. creosoted piling at $0.28	$16.80
Hauling piling	2.00
Driving piling	9.42
120 ft. b.m. uprights, $36 on job	4.32
80 ft. b.m. stringers, $16 on job	2.88
Placing lumber and bolts, including boring holes	$47.00
Painting	1.00
Bolts and nuts	4.80
Supervision	5.00

Cost per 10 linear feet of completed

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fender	$93.22
Cost per linear foot	9.32

Bottom stringers and bolts below low water, 2 hours work per day, all timber floated out in position, bored and bolted, and placed by men in small row boats, no scows or lighters to be had.

SCALE OF WAGES

Pipe-layers, $2 per 10-hour day.
Cinchers, $2 per 10-hour day.
Banders, $2.25 per 10-hour day.
Spacers, $2.25 per 10-hour day.
Painters, $1.75 per 10-hour day.
Laborers, $1.75 per 10-hour day.
Superintendent and engineer, $11.66 per day—$350 per month.
General foreman, $5 per day.
Gang foremen, $3 to $4 per day.
Excavating foremen, $3.50 per day.
Pump-men, $3.50 per 10 hours.
Watchmen, $2 per 10 hours.

Wages paid were high, as all work was in water always at least 18 inches deep, boots' average life 4 weeks with good care, cost $5.50 per pair wholesale. Hard to keep men at work, 600 to 700 on payroll—200 to 300 working.

COST OF DRIVING PILES FOR MANHOLES

Four 30-ft. piles for each manhole. Manholes 1000 ft. centre to centre. Cost includes building pile-driver, assembly of plant, driving piles, moving driver, dismantling, and returning to store-yard and completion.

Lumber for machine, except skids	$90.00
Delivery at Absecon camp	20.00
Hauling engine from Atlantic City to Absecon	15.00
Bolts, lines, bars, rollers, nippers, tools, etc.	80.00
Labor assembling driver—foreman carpenter at $5; 3 laborers at $2, 4 days	44.00
Total cost plant	$249.00
Dismantling engine and haul to yard	10.00
Dismantling leads and skids and haul to yard	22.00
Less credit for skids, rope, and tools charged to another branch on completion of driving	56.00
Total charge against the work for plant	$225.00

It must be remembered the machine started at Absecon end and worked toward Atlantic City, all piles were delivered at Absecon, with exception of 12, which were delivered on 'Old Turnpike road,' therefore machine had to carry with it 40 piles. As each manhole required 4 piles, each move meant 4 piles less to drag forward, but you can see the handicap the work was done under, having no base of supplies. This crew started out before track was laid or shanties built, and water sometimes 2 ft. deep on meadows, so that machine had to be blocked up or fire would be put out.

PILE-DRIVING CREW

1 foreman at $4	$4.00
1 engineman at $3.50	3.50
1 top-man at $2.25	2.25
4 laborers at $2	8.00
2 hours of supt's time at $1.16	2.32
2 hours of timekeeper's time at $0.30	0.60
Coal, delivered within 2 miles of work, and carried in 50-lb. sacks across marsh by men, per day—coal cost delivered $5 per ton	4.10
Water rolled in barrels ½ mile across marsh	1.05
Oil, waste, etc.	0.09
Rental charge on engine and boiler	2.00
Total cost per day	$27.91
Number of days worked	0.16
Total cost of labor	$446.56
Total cost of plant	225.00
Entire cost of work	$671.56

52 30-ft. piles driven in place—

4 piles, each 1000 ft., cost per pile	$12.915
Cost per linear foot of pile	0.43

MANHOLE GANG

1 foreman at $3.50	$3.50
6 skilled laborers at $2	12.00
1 hour timekeeper at $3	0.30
1 hour superintendent at $11.66	1.16
Percentage of waterboy	0.09
Cost per day	$17.05
Time required to set manhole complete, 2 days	2
Labor cost to set	$34.10
Percentage of plant cost	1.30
Unloading and hauling material	5.00
Cost, each	$40.40

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Cost of constructing manholes on meadow upon piles driven by pile-driving crew. Weight of completed manhole 4½ tons. Composed of 1 T (4000 lb.), 2 bells and flange-pins (4200 lb.), 88-1½ by 7¼-in. Tobin bronze bolts and Crex nuts, 2½-in. seamless tubular lead gaskets, 1 manhole plate and bolts. Base of supplies, average 1½ miles. Plant used to set manholes: one tripod, one 5-ton chain-hoist, one 2-ton chain-hoist, six 10 by 10-in. by 30-ft. timbers, 8 by 8-in. blocking, chains, tackle, wrenches with 3-ft. handles, spades, cross-cut saws, diaphragm pump, 1 timber cart, wheels 48-in. with 10-in. tread (iron), cant hooks, etc., rollers.

MANHOLES

Unloading from cars at Absecon and hauling to end of track at Absecon camp, $1 per ton by contract	$5.00
Loading on cars and transporting to end of track	2.10
Unloading on cribs	0.80
Excavating around piles 8 by 8 by 3 ft. 6-in. water-level at surface requiring constant pumping	3.30
Cutting off 4 piles and capping	0.60
Skidding casting over hole and cribbing	6.20
Bolting on 2 bell pieces, including gaskets	12.00
Lowering into position and adjusting	3.10
Supervision	6.00
Percentage of plant cost, less credit	1.30
Total labor cost each for setting	$40.40
Total labor cost each for piles	51.66
Total labor cost for foundation and setting	$92.06
Cost of 4 piles, delivered	16.00
Cost of 2 caps, delivered	2.04
Final cost, including piles, foundation, and labor	$110.10

Cost of building intersection at Sta. 78 + 0, composed of two 42 by 48-in. reducers, two 42-in. gate-valves, one 42 by 42 by 42-in. T, one 42-in. blank flange, 200 Tobin bronze bolts, five lead gaskets, etc. Nearest supply depot three miles. Intersection located within 300 ft. of W. J. & S. railroad main line, made arrangements with railroad to load all material on flat-car at Atlantic City, haul to job at night, and railroad to unload all material on ground by railroad derrick.

Unloading from cars at Atlantic City at contractor's plant, by derrick, of all material for intersection	$8.70
Loading on flat-car at contractor's plant at Atlantic City of all material and tools for intersection	12.30
Hauling to job by railroad and unloading on ground, railroad derrick used	25.00
Excavation, 8 by 8 by 3 ft. 6 in., water-level at surface requiring constant pumping	18.23
Cutting off 12 piles and capping	1.97
Laying boards for track to skid castings	2.00
Skidding over in position over caps of all castings	62.10
Bolting up, including gaskets and blocking	42.00
Removing blocking and lowering into position	18.30
Supervision	18.00
Percentage of plant cost, less credit	2.60
Total labor cost for setting	$211.20
Total labor cost for piles	154.98
Total labor cost for foundation and setting	$366.18
Cost of 12 piles, delivered	48.00
Cost of caps, 10 by 10-in., delivered	19.82
Final cost, including piles, foundation, and labor	$434.00

Comparative Strength of Tile and Concrete Wall-Sections*

THE Robert W. Hunt Co. has recently conducted a series of tests of the comparative strength of tile and concrete wall-sections. The tests were conducted for the National Fireproofing Co., at their new laboratory in Chicago.

This testing station is of modern construction and equipped with a 300-ton hydraulic

*Abstract from *Concrete-Cement Age*, October 1912.

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TESTS OF TILE, BRICK, AND CONCRETE WALL-SECTIONS

Tests of Walls About 12 ft. High.

Material.	Age, days.	Horizontal dimensions, inches	Unit stress at failure, lb. per sq. in., gross cross-section	
Brick wall	47	8 by 33¾	248	
Concrete wall	49	8 " 36	1610	
Reinforced concrete walls	55	8 " 36	2060* first loading 1920 second loading	no signs of failure
Interlocking tile wall; side	13	8¼ " 37	288	
Monarch tile pier (laid up of 4 by 8 by 8 tile on end)	25	8¼ " 8¼	2911	
Monarch, 4-in. wall	25	4 " 33¾	2560†	
Monarch, 8-in. wall	47	8¼ " 37	1354	
Monarch, 8-in. wall	35	8¼ " 37	1130	
Monarch, 8-in. wall	26	8¼ " 36½	1680	
Natco, 8-in wall	28	7¾ " 35	570	
Natco, 8-in. wall	33	8 " 36½	1220	
Natco, 8-in. wall, side	28	7¾ " 36¾	292	
Natco, 10-in. wall, side	33	9¾ " 36¾	415	

*Note that this is not unit stress at failure. †Buckled.

testing machine, which will accommodate structural test specimens up to 12 ft. high and 3 ft. wide. The cylinder and ram are set on a concrete foundation, and the ram has a spherical bearing for the lower (sliding) cross-head to insure uniform pressure. For handling the specimens and the upper cross-head, there is a traveling crane which serves the entire floor. The pressure pump is at one side of the room.

The log of the test is as follows: The specimens included sections of a wall 12 ft. high and 4 by 36 and 8-in. section. All were tested to destruction except the concrete.

Concrete.—A reinforced-concrete wall-section was tested on May 14. It was a 1:2:4 concrete of 'Owl' cement, torpedo sand, and ¾-in. crushed limestone. The wall was reinforced with eight ⅝-in. round rods, four on each side, 1 in. from the exterior surface and ½ in. from the ends, interwoven with No. 14 gauge wire netting. The specimen was 40 days old. It lacked the horizontal reinforcing usually found in practical construction. Upon this specimen, loads of 10-ton increments were applied at 2-minute intervals. The first deflection occurred at 10 tons and was 0.005 in. The final load was 300 tons, the capacity of the machine. The deflection was 0.005 in. The concrete did not give even an indication of failure, the load being approximately 2060 lb. per square inch. The load was released and then rapidly reapplied up to 275 tons. There was no indication of failure. All that happened was a slight loosening of the seating mortar from the sides of the concrete.

Another wall-section of the same type was tested. It developed a compressive strength of 2084 lb. per square inch. The load was allowed to remain 45 minutes and then reduced to zero. It was again applied rapidly up to 275 tons, when the testing machine was broken. The specimen was removed without being crushed.

A third specimen of concrete without reinforcement developed a strength of 1610 lb. per square inch. A small vertical crack occurred at 215 tons and advanced slowly up the centre of the specimen until it failed in shear about 2 ft. from the bottom.

Brick.—A brick wall was tested. It was laid in the lime mortar in accordance with the Chicago building code. It failed after it had shown a compressive strength of 248 lb. per square inch. The bricks were so loose they could be picked out by the hand.

Tile.—The following is a brief summary of

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the hollow tile tests:

A hollow tile wall 28 days old, set on end in cement mortar. Load applied in 5-ton increments at two-minute intervals. Elastic limit was reached without rupture, only a small crack running up centre of the specimen. One tile in the fourth pier from the top cracked at a total load of 79 tons. Maximum load per square inch, 570 pounds.

Another tile wall 28 days old was tested. Tile was laid on sides. Failed suddenly in shear at 42 tons. Compressive strength, 292 lb. per square inch.

A hollow tile wall 46 days old was tested, said to have been built of rejected material. This failed completely in the sixth and seventh courses at 195 tons. The tile was completely crushed. The compressive strength developed was 1354 lb. per square inch.

Hollow tile, medium burned, was used in one wall, which failed suddenly at 175 tons. The fibre stress was 1215 lb. per square inch. There was no preliminary warning of failure.

A column of tile 8 in. square, 12 ft. high, failed at 93 tons, at a fibre stress of 2911 lb. per square inch.

A section of tile wall 4 in. thick, 36 in. long, and 12 ft. high showed cracks at 145 tons and failed at 175 tons. The fibre stress was 2430 lb. per square inch. One side of wall was completely crushed, the other standing. This wall behaved in a peculiar manner. It deflected horizontally 0.025 of an inch in one direction, came back vertically, and then deflected an equal amount in the opposite direction.

Diesel Motor Vessel, 'Christian X'

THE *Christian X* of the Hamburg-American Line is the first motor liner to cross the Atlantic, having sailed from Hamburg direct to Havana and thence to New Orleans. Her voyage has been highly successful, proving that the oil engine is entirely practicable for large steamers under all conditions.

The motor liner *Christian X* was built at the yards of Burmeister & Wain, in Copenhagen, according to Lloyd's highest-class specifications. She measures 370 ft. between perpendiculars, 53 ft. beam, her hurricane deck rising 30 ft. above the water. She can carry 7400 tons, her displacement, loaded, is about 9800 tons, her capacity is 4900 gross registered tons or 3200 net registered tons.

In the new vessel, steam engines, boilers, furnaces, and coal bunkers have all been done away with. The driving machinery, which is extremely compact, is controlled directly by the touching of a lever. The engine room force, including coal heavers, trimmers, etc., have been greatly reduced, and the arduous work of coal heavers has been done away with, while coaling is no longer necessary. The compact machinery has made possible important economy of space, which is used for additional cargo. The *Christian X*, with her sister ship, *Selandia*, have been added to the regular service of the Hamburg-American Line.

The motor ship *Christian X* left the River Elbe, July 23, bound for Havana. Passing out of the English Channel, a trial run of 24 hours was made on the open Atlantic, absolutely free from any currents and under fine weather conditions. The log shows that she averaged 11½ miles per hour. She subsequently met rough weather, but throughout the voyage her engines worked smoothly and without interruption. She arrived at Havana August 9, after a voyage of 17 days, covering 4627 miles, at an average speed of 11.01 miles per hour, with 290 tons of fuel oil in her tanks, thus fulfilling every expectation.

The fuel oil is carried in the double-bottom tanks, holding about 1000 tons of oil. One of the great advantages of the motor-driven ship is the remarkable control of its machinery. The engines of the *Christian X* when at full speed may be reversed to 'full speed astern' in about eight seconds. The vessel can thus be controlled directly by levers operated from the engineer's platform. The almost instant control from the bridge makes it possible to avoid collisions against which a steamship would be powerless. The

*Abstract from *Pacific Marine Review*, October 1912.

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exhaust gases of the engine are cooled in a special chamber and led to the outer air through a hollow mast and discharged at a height of 49 ft. above the deck. All of the auxiliary apparatus of the liner is in duplicate, so that in case of accident there would be no interruption.

The Diesel engine operates dynamos which furnish electric current for operating the pumping plant, cooling machines, steering gear, and the winches for handling cargo. The vessel is also equipped with electrically driven carbonic-acid-gas refrigerating machines. The vessel is divided into seven water-tight compartments.

The passenger accommodations of the liner are extremely attractive. The staterooms are roomy and free from any sense of crowding. The public saloons are built with unusually high ceilings which lend them the effect of luxurious rooms ashore. There is a dining saloon, a ladies' saloon, and a smoking room luxuriously furnished in keeping with the standards of modern luxury in travel.

The *Christian X* left New Orleans September 13, reaching New York early on the morning of September 19, sailing at an average of 13 knots per hour. On September 14, while in the gulf stream, the motor ship was halted for five hours to carry out a series of tests in stopping, starting, etc., and she was found to be under instant control from the bridge. While sailing at full speed the *Christian X* consumed ten tons of oil per day. Since the fuel capacity is 1000 tons of oil, she can sail for more than 100 days without replenishing the supply, a distance equal to the circuit of the globe. A steamer of the same size and speed would use from 40 to 50 tons of coal per day. The *Christian X* has a crew of 46 men, only 10 of whom are employed in the engine room. A coal burning steamer of the same size and speed would require a crew of 40 men in the engine room alone, added to which would be the extra labor for loading coal.

An Oil and Compressed Oxygen Explosion*

A SEVERE explosion in connection with the starting up of a Diesel engine occurred recently at Bray, Ireland, and it carries a lesson which should be heeded. The circumstances of the accident are presented clearly in the report of the matter by D. E. McDonnell, the assistant electrical engineer, who wrote as follows:

"On Sunday, the 7th inst. (July), the starting air of the Diesel was lost, and, following the instructions of the engine builders, Mr. Sowter sent to Dublin for a 40-ft. cylinder of oxygen. On the 10th we charged the blast receiver from this cylinder, raising the pressure from 350 lb. to 700 lb., and also passed a little into one of the starting receivers; the pressure in the latter was about 350 pounds.

"I started up the engine in the usual manner, and, going on to platform, put the starting lever into the running position. The engine did not appeared to be running properly, but before I could discover what was wrong the fuel valve on the cylinder cover of the engine exploded; the flame from this burst along the blast pipe, reaching the blast receiver, which then also exploded.

"I attach copy of the paragraph from the makers instruction-book which relates to the use of oxygen. From this you will see that we had every reason to believe that there was nothing hazardous nor very unusual in using this gas:—'If by any mishap the air is lost, and no compressor available, or if the engine cannot be run by external means so as to charge the receivers with its own compressor, then these may be charged with carbonic acid gas or oxygen from cylinders containing these compressed gases, as used for many purposes.'

"In the ordinary course of events there would be no explosive mixture in these receivers, and I consider that there is no danger of a repetition of such an explosion. Personally, I will have quite as much confidence in the Diesel engine as I had before the accident."

The *Electrical Review* has, by inquiries, elicited the fact that the connection from the blast receiver to the fuel valve of the engine consists of about 14 ft. of ⅜-in. bare copper tube. Crude Texas oil fuel has been used since the engine was installed, about 2½ years ago.

*Abstract from *Compressed Air Magazine*.

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Industrial Progress

Welding a Gyratory Crusher Spindle

An interesting application of the thermit welding process has recently been made by the San Francisco office of the Goldschmidt Thermit Co. The Healy-Tibbitts Construction Co. was operating a No. 3 McCully gyratory crusher at its rock-crushing plant and was at work making a large quantity of crushed rock for one of its contracts which necessitated steady deliveries in order to keep up with the field force engaged on the work. The centre spindle of the No. 3 crusher broke, thus temporarily putting the entire plant out of commission and stopping deliveries of crushed rock until repairs could be made. As a spare spindle could not be obtained in San Francisco, the delay incident to sending East for the part was a serious matter to the contractor. After giving careful consideration to the situation, L. S. Rosener, consulting engineer for the contractors, referred the matter to the San Francisco office of the Goldschmidt Thermit Co., which agreed to undertake the work of making the repair.

The spindle was shipped to San Francisco from the rock quarry at Point Molate, three miles west of Point Richmond. Fig. 1 shows the condition of the broken spindle when it was received. It was in two pieces and fractured on the line indicated at the end of the V thread. The shaft was first put in the lathe to be tested for alignment, and it was found to be one-eighth out of true; 1⅛ in. of stock was then turned off to provide space for the thermit, and a 2-in. pin was fitted into the larger end of the shaft and a hole was bored 4½ in. deep in the smaller piece of shaft, into which the pin was fitted, thus insuring perfect alignment after welding. This being done, the shaft was placed on V-blocks at each end,

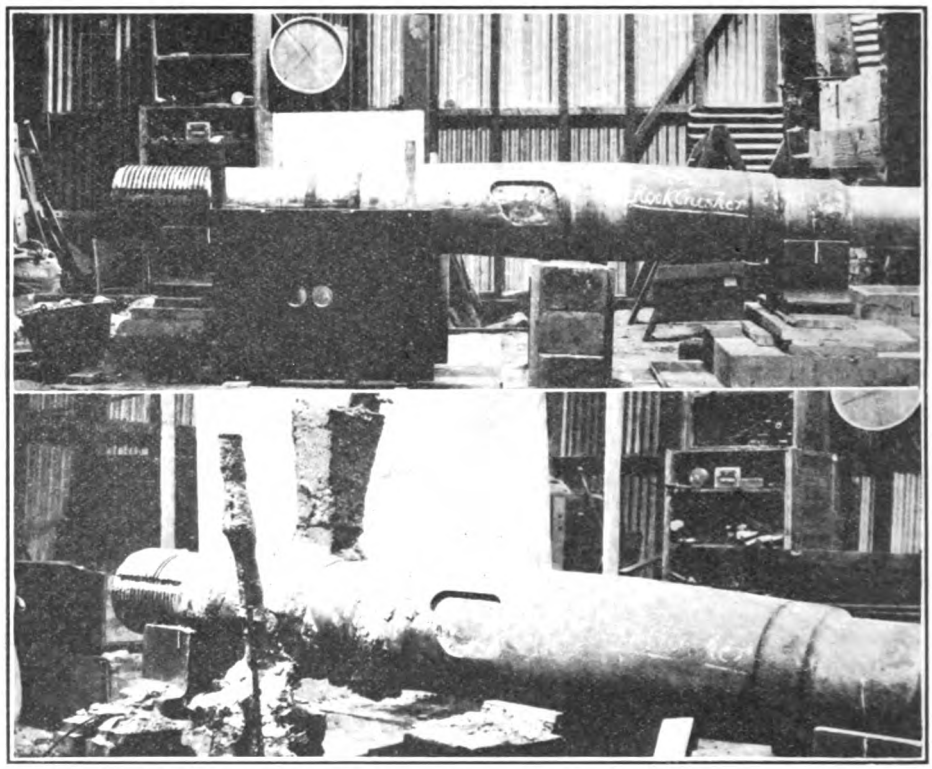

FIG. 1. BROKEN SPINDLE.
FIG. 2. SPINDLE AFTER DISMANTLING MOLD.

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and blocks also supported the pin near the middle, and one piece of shaft was strapped down to the blocks. A mold box was made with wooden sides which were made to taper so that the gate would have sufficient incline from the vertical. The end containing the torch holes was of No. 10 steel. One No. 8 crucible was used, and the mix consisted of 150 lb. of thermit, 2½ lb. of manganese, and 3 lb. of puchings. There was 44 lb. of metal in the riser. The metal was of exceptionally good character with very few blow holes; in fact, the casting was so successfully acomplished that it permitted turning and shaping V thread without showing any external effects. Fig. 3 shows the spindle ready for molding, and Fig. 2 shows the spindle after dismantling.

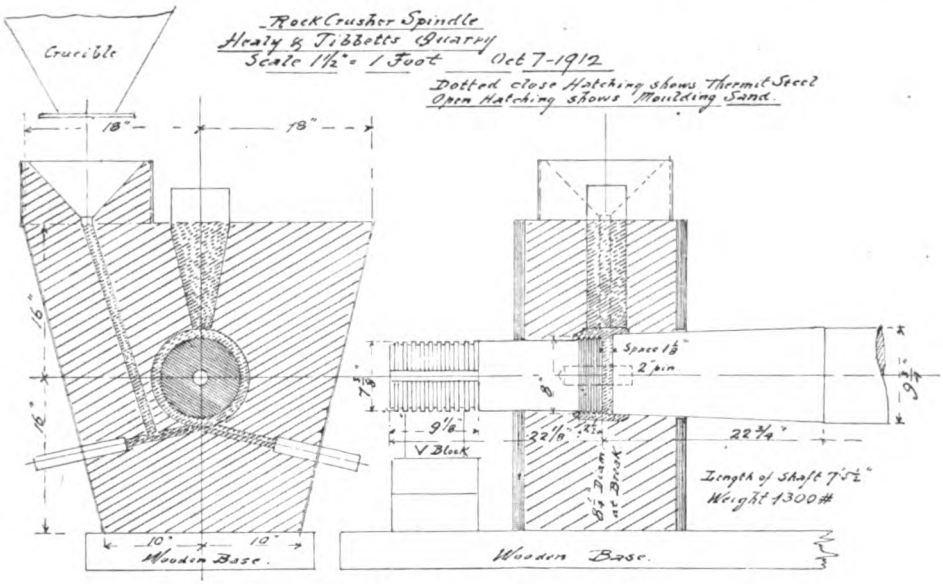

FIG. 3. READY FOR MOLDING.

It is difficult to imagine any more severe test of the efficiency of the thermit welding process than is shown in this specific instance. The crusher spindle is subjected to severe bending and torsional strains, and is also subject to shock, the character of the load being more or less intermittent and widely varying in its character. Practically all of the breaks in crusher spindles of this kind are due to crystallization superinduced by fatigue. On October 21 the shaft had been in practically constant operation for two weeks with perfect satisfaction, the portable dryer and heater for the aggregate crusher not having been spared in any way; and to all intents and purposes the repair thus effected will last indefinitely.

Handy Contractors' Equipment

Contractors' equipment designed for use in building bituminous asphalt roads has recently been placed on the market by the Ruggles-Coles Engineering Co., New York City. The outfit consists of a Ruggles-Coles and a Ruggles-Coles mixer. These are mounted on the same portable truck as the boiler and engine which furnish the power. The aggregates are conveyed from the receiving hopper to the dryer by bucket elevator. In passing through the dryer the moisture is removed and the temperature of the material is raised to about 350°F. The passage through the dryer requires about 15 minutes. The material as discharged from the dryer falls into the boot of a second elevator which raises it to a storage-bin over the mixer. From this bin it is drawn into the measuring box over the mixer.

The asphalt is heated in kettles adjacent to the equipment and is pumped by an ordinary reciprocating pump to a measuring bucket alongside of the material box above the mixer. The aggregates and the asphalt are then dumped into the mixer together.

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Engineering Bonds

*Tax exempt in California.
†Legal investment for savings banks in California.
‡Available as security for deposit of state, county, and municipal funds and postal savings deposits.

San Joaquin Light & Power Corporation has filed an application with the Railroad Commission asking for authority to issue bonds in the sum of $925,000. The company desires to issue $320,000 of these bonds at the present time and the balance at a later date. The proceeds of the present issue are to be used for taking up and refunding notes outstanding.

Central California Gas Co. has been authorized by the Railroad Commission to issue additional bonds to the amount of $219,000 and additional preferred stock to the amount of $136,200. The proceeds of this issue are to be used for the purchase of the Consolidated Heat, Light & Power Co. of Visalia and Tulare, and for the construction of a transmission line from Exeter to Visalia, to constructing additions to the gas plant in Visalia and the distributing systems in Visalia and Tulare, to install an electric distributing system and gas-holder in Porterville, to construct a transmission line from Porterville to Lindsay, to construct a transmission line from Lindsay to Exeter, to construct a distributing system in Lindsay and in Exeter.

The Seaboard Oil & Transit Co. has been authorized by its stockholders to issue bonds to the extent of $2,500,000. A statement presented to the stockholders showed that the company's assets were $1,708,446.80, and the liabilities $348,918.59. The proceeds of this issue are to be used to refund outstanding indebtedness and $1,000,000 is understood to have been underwritten by a European syndicate which will provide funds for development of the company's properties in Mexico.

Sixth installment of 15% of the $4,000,000 bond issue of the General Pipe-Line Co. of California has been paid, leaving one installment of 10% payable December 10, 1912, and the last installment of 5% payable January 10, 1913. The company is constructing a pipe-line from Midway and other fields to Los Angeles and San Pedro harbor about 175 miles long in all. It is stated that the company will commence business with a contract to carry a minimum of 15,000 bbl. of oil per day, representing net earnings of $845,750, leaving a net profit surplus of $605,750, after paying interest at 6% on the total bond issue. The surplus, after providing for a sinking fund of 7½% per year, or $300,000, would amount to $305,750, or 15% on the 8% guaranteed stock. The company expects eventually to transport 25,000 bbl. of oil per day.

The City of Pasadena has issued $150,000 in 4½% water bonds, due from 1922 to 1932. This is part of the total issue of $1,000,000. The assessed valuation of the City of Pasadena is $49,112,785, and the bonded indebtedness, including this issue, is $2,053,850.

San Diego Consolidated Gas & Electric Co., subsidiary corporation of the Standard Gas & Electric Co., has called a special meeting of stockholders, to take place on December 23, to vote on a proposed increase of the bonded debt not to exceed $3,000,000. The new bonds are to be issued to provide funds for discharging floated indebtedness.

San Francisco Harbor and State Highway Improvement bonds to the extent of $2,050,000 were offered by the State Treasurer at auction on November 12. Of this amount the State Board of Control has purchased $250,000 of harbor bonds. State Highway bonds to the amount of $800,000 have been sold, making a total disposal to date of $1,600,000.

City of San Diego proposes to offer in December $2,500,000 in 4½% bonds to provide funds for the purchase of the Southern Mountain Water Company.

Southern California Utilities Co. has been authorized by the State Railroad Commission to issue bonds in the sum of $10,000,000. The funds provided by this issue will be used for the development of an extensive land and irrigation system embracing 30,000 acres in Riverside county. This company has been recently organized, having issued its stock shortly prior to March 23. It proposes to use funds for the following purposes: For the purchase of the rights and property of the Ramona Power & Irri-

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gation Co., $350,000; for the purchase of the so-called Whittier properties, embracing the Lake Hemet Water Co., the Fairview Land & Water Co., the Hemet Town Water Co., and the Hemet Land Co., $1,417,992; for the purchase of two-thirds of the stock of the California-Riverside Land Co., owning 30,000 acres of land, $3,150,000; for the construction and development of an irrigating system and power plant, $4,117,000. The balance is to be devoted to the improvement of lands, water properties, etc. The bonds are to be sold to net the company $9,674,992, and in the hearing before the Commission it was stated that they would be purchased by English capitalists.

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†Los Angeles Railway Corporation has issued $3,000,000 first and refunding 5% gold bonds, due December 1, 1940, and are not callable. The company has $20,000,000 common stock outstanding and the present bonds are part of the total authorized issue of $20,000,000. Of this amount, there is $14,305,000 outstanding, while there are underlying bonds amounting to $5,352,000. The company reports earnings as follows:

	Year ended June 30, 1912.
Gross earnings	$6,206,294
Operating expenses, taxes, maintenance, and rent	4,315,189
Net earnings	$1,891,105
Interest on bonds	1,002,500
Surplus	$ 888,605

The company operates and owns the entire local street-railway system of Los Angeles, comprising about 357 miles of single-track railway, of which 2.42 miles are owned and leased from the City Railway Company of Los Angeles, a subsidiary company, all of the stock of which is owned by this corporation. The present system is a consolidation of the various street railway lines of Los Angeles, including lines formerly owned by the Pacific Electric Railway Co., the Los Angeles Interurban Co., and the Los Angeles & Redondo Railway Company.

United Railroads has applied to the Railroad Commission for authority to issue $2,350,000 6% five-year notes. On January 1, 1913, $3,000,000 Market-street Cable first-mortgage 6% bonds, and $350,000 Park and Cliff House Railway first-mortgage 6% bonds, will fall due. These bonds will be redeemed from the proceeds of the sale of $2,350,000 five-year 6% serial gold notes and from moneys now in the sinking fund for that purpose. All, but no part, of these notes will be callable at 102½ and accrued interest on any interest-payment date. They will be collaterally secured by $2,150,000 Market-street Railway first consolidated mortgage 5% bonds, due 1924, and by $970,000 San Francisco Electric first-mortgage 5% bonds, due 1932. The United Railroads report the following earnings for the year ended September 30, 1912:

Gross	$8,353,879.75
Operating expenses (including taxes, maintenance, and rent of leased lines, equipment, and depreciation)	5,274,797.67
Net earnings	$3,079,082.08
Fixed charges (including bond interest and interest on floating debt)	1,952,191.65
Surplus	$1,126,890.43
Less interest on Market Street Cable bonds and Park and Cliff House bonds to be retired January 1, 1913	201,000.00
Surplus available for interest on $2,350,000 6% notes to be issued November 1, 1912	1,327,890.43
Interest on $2,350,000 6% notes to be issued	141,500.00
Balance	$1,186,390.43

Corona Power & Water Co. has issued $20,000 first-mortgage 6% bonds, dated March 1, 1903, due March 1, 1923. These bonds are secured primarily by a first mortgage on 3600 acres of water-bearing land, also electric-power plants and eight electrical pumping stations situated on different portions of the 3600 acres. The total value is conservatively $412,000. Secondary security of these bonds is a mortgage on all the other property of the Temescal Water Co., subject only to the lien of the first mortgage bonds of the latter company.

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Company Reports

Pacific Gas & Electric Co. has issued its annual report for the year 1911. Statistics of electric generating and distributing, gas, water, and electric street railways are as follows:

Electric Generating Statistics, Hydro Section—

Number of power-houses	11
Total installation in horse-power	92,973
Load-factor for year	0.666
Total capacity storage reservoirs, cu. ft.	1,257,612,916
Miles high-tension transmission lines	1,555
Number of sub-stations on transmission lines	105
Peak demand on system in horse-power	115,000

Electric Generating Statistics, Steam Section—

Number of steam plants	5
Total installation in horse-power	60,323
Number reciprocating engines	15
Number turbines	2
Number boilers	49
Horse-power in boilers	26,945

Electric Distribution Statistics—

Number of electric consumers	102,198
Miles of overhead dist. lines	1,910
Miles of underground conduit	65.81
Number of street lamps:	
Arcs	6,119
Incandescent	10,191
Total connected load on system on basis of 50-watt lamps	4,595,981

Gas Department Statistics—

Number of gas consumers	177,510
Number of gas plants	16
Total gas sold, cu. ft.	6,187,583,000
Number of gas holders in use	41
Total capacity of gas holders, cu. ft.	18,930,300
Number of gas generators	42
Total daily capacity of generators, cu. ft.	34,680,000
Miles of gas mains	1,917.71
Number of services laid	171,934
Number of gas arcs installed	4,932
Number of gas street lamps	8,342

Water Department Statistics—

Number of water consumers	7,398
Number of pumping stations	3
Gallons of water pumped	1,201,358,695
Capacity reservoirs, cu. ft.	2,553,651,500

Electric Street Railway Statistics, Sacramento—

Miles of street railway track	38.98
Cars owned	62
Total passengers carried	11,464,696
Gross revenue	$533,519.92
Car mileage	2,279,998
Car hours	293,107
Passengers per day	31,410
Passenger receipts per car mile	$0.234
Passenger receipts per car hour	$1.91
Number of electric railway systems supplied	8
Mileage of electric railway systems supplied	640

Additions to physical plant in 1911 included 408 miles of gas mains, 125 miles of transmission lines, 500 miles of distributing lines, four miles of water mains, 4.1 miles of street railway tracks, 18,415 gas and electric water service, and 6901 gas supply appliances. Increase in the total number of consumers included: gas 23,924, electricity 17,869, water 968, making at total of 42,781. Thirteen thousand five hundred ninety-two horse-power in new business as contracted for during 1911, to be used entirely for industrial and agricultural purposes in addition to the lighting load represented by 27,971 hp., making a total increase in installed load on the system of 41,563 hp. The company's plans now in progress of consummation include building additions to hydro-electric plants, aggregating 76,000 kw. in connection with the dam at Lake Spaulding, having a capacity in addition to the present water storage of 4,000,000,000 cu. ft., which after being utilized for power purposes will add to the company's irrigating capacity 20,000 acres of land in Placer county.

The Oregon Electric Railway Co. reports earnings for the year ended June 30, 1912, as follows:

	1912.	1911.	Changes.
Gross revenue	$787,476	$616,079	$171,397*
Net revenue	306,942	292,567	14,375*
Net income	263,780	267,404	3,624*
Surplus	147,297	167,404	20,107†

*Increase. †Decrease.

All of the common stock of Oregon Electric is owned by the Spokane, Portland &

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Seattle railway, which is jointly controlled by the Northern Pacific and Great Northern. It operates about 135 miles of electric line in the Portland district, of which 60 miles between Salem and Albany have just been placed in operation.

California Petroleum Corporation.—Report on the properties of the American Petroleum Co. and the American Oilfields Co. of California, now known as the California Petroleum Corporation, has been made by Ralph Arnold. A summary of the properties owned by the combined companies is as follows:

Location.

Coalinga, Lost Hills, McKittrick, Midway, Sunset, and Los Angeles districts, California.

Lands.

	Acres.
Proved	3,786.12
Prospective	2,712.00
Doubtfully prospective	12,318.00
Total acreage	18,816.12
Percentage proved land drilled	14.5
Percentage proved land to be driled	85.5

Wells.

Producing	110
Drilling or idle	39
Possible number on proved land	757
Percentage already drilled	14.5

Oil Supply.

Oil already produced, bbl	12,994,700
Available supply remaining, bbl	295,087,427
Value available supply at 10c	$29,508,742.70
Percentage already produced	4.00

Contracts.

Amount contracted, bbl	18,044,409.00
Amount delivered, bbl	9,411,291.63
Balance to be delivered, bbl	8,633,117.37
Value contracted oil	$9,984,919.07
Value oil sold	5,163,711.51
Value oil to be delivered	$4,821,207.56
Total value physical assets oil supply	$32,730,023.02

The general information contained in the report has been brought, as far as possible, up to March 1, 1912, and the data given are based upon Mr. Arnold's personal experience of the past six years, and during the greater part of which time he has been engaged in making examinations of the oilfields in behalf of the U. S. Geological Survey.

AMERICAN PETROLEUM COMPANY.

Location.

Coalinga, Lost Hills, and Los Angeles districts, California.

Lands.

	Acres.
Proved	1,436.12
Prospective	972.00
Doubtfully prospective	928.00
Total acreage	3,336.12
Percentage proved land drilled	26.0
Percentage proved land to be drilled	74.0

Wells.

Producing	76
Drilling or idle	15
Possible number on proved land	287
Percentage already drilled	26.0

Oil Supply.

Oil already produced, bbl	7,833,512
Available supply remaining, bbl	160,451,615
Value available supply at 10c	$16,045,161.50
Percentage already produced	4.6

Contracts.

Amount contracted, bbl	13,657,984.00
Amount delivered, bbl	6,775,778.20
Balance to be delivered, bbl	6,882,205.80
Value contracted oil	$7,797,830.12
Value oil sold	3,919,176.98
Value oil to be delivered	$3,878,653.14
Physical properties and unproved land	$1,185,936.89
Total value physical assets and oil supply	$17,231,098.39

Of the total acreage held by the American Petroleum Co. under various titles, 1396.12 is in the Coalinga district. The original amount of oil recoverable is given at 167,500,000 bbl., the total produced to date of report 7,209,056 bbl., leaving an amount available of 160,290,944. The company's property in the Kreyenhagen field includes 1260 acres, of which Mr. Arnold considers that all except 248 acres in Section 16 and all of Section 5 is of no value from an oil-producing standpoint. In the Lost Hills district the property of the company includes 600 acres of patented land which Mr. Arnold considers there is but small chance that it may become pro-

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ductive. In the Los Angeles district the property is held in the name of the Niles Lease Co., which produced, from May 11, 1908, to December 31, 1910, a total of 643,205 bbl., and from January 1, 1911, to March 1, 1912, 137,365 bbl., a total of 780,570 bbl. This property consists of the 80-acre lease at the western end of what is known as the old Salt Lake field, about a half-mile southeast of Sherman. The report predicts that an average well on this lease will have an economic life of at least 15 years more. This conclusion is based upon the great thickness and quality of the sands, the constancy of the gas flow, and the quality of the product. Mr. Arnold has given an estimated total product recoverable in the next 15 years of 981,409 barrels.

AMERICAN OILFIELDS COMPANY.

Location.

Midway, Sunset, McKittrick, and Lost Hills districts, California.

Lands.

	Acres.
Proved	2,350
Prospective	1,740
Doubtfully prospective	11,390
Total acreage	15,480
Percentage proved land drilled	7.2
Percentage proved land to be drilled	92.8

Wells.

Producing	34
Drilling or idle	24
Possible number on proved land	470
Percentage already drilled	7.2

Oil Supply.

Oil already produced, bbl	5,161,188
Available supply remaining, bbl	134,635,812
Value available supply at 10c	$13,463,581.20
Percentage already produced	4.6

Contracts.

Amount contracted, bbl	4,386,425.00
Amount delivered, bbl	2,635,513.43
Balance to be delivered, bbl	1,750,911.57
Value contracted oil	$2,187,088.95
Value oil sold	1,244,534.53
Value oil to be delivered	$ 942,554.42
Physical properties and unproved land	$2,035,343.43
Total value physical assets and oil supply	$15,498,924.63

In discussing the properties in the McKittrick, Midway, and Sunset districts, it is shown that the quality of oil on tract H in the Midway-Sunset district varies between 16 and 24°B.; the average of that delivered in the pipe-line is 19°B. Well No. 19 on this tract is about 16°B., while that of well No. 57 is 24°B. The oil produced on the old Monte Cristo property varies between 20 and 22°B., while that produced on the Midland Oil Co.'s property averages about 16°B. The present daily production of the three producing properties on tracts H, I, and L varies between 6868 bbl. and 7878 bbl. The average loss of oil, due to seepage and evaporation, on sections 25 and 36 is about 21,500 bbl. per month in January and February, 1912. Total storage capacity on tracts G, H, K, and L is 1,666,000 bbl. Tract E of the Midland Oilfields Co. consists of 480 acres of unpatented land, on which there are at present two producing wells and one in the course of drilling. The capacity of the producing wells is said to be 25 and 35 bbl. per day, respectively, of about 16°B. oil. Tract F of the Midland Oilfields Co. includes 480 acres of unpatented land and adjoins tract E on the southeast, and has one drilling well on the centre of the section. Tract G includes an area of 80 acres for which application for patent has been made. There is one producing well and one well which has not yielded oil in commercial quantities. Tract H of the American Oilfields Co. has an area of 480 acres of unpatented land. There are at present 24 producing wells on the property, one water well, four drilling, one just cemented, two abandoned, and one idle. The total production of these wells is 6490 bbl. per day, of oil varying between 16 and 24°B. Tract I of the Midland Oil Co. includes 160 acres of patented land leased from the Lockwood company on one-fifth royalty. There are at present six producing wells on this property and two water wells. The oil varies between 10 and 24°B., the oil delivered averaging about 16°. The gross production per day varies between 265 and 365 bbl. Tracts J and K of the American Oilfields Co. include 600 acres and have 10 wells and one water well, none of which, however, are commercially productive at present, although four of the wells have all produced more or less oil. Tract L of the Midland Oilfields Co. includes 80 acres freehold and 50 acres

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lease. There is one producing well, two drilling wells, and one water well. The quality of the oil produced varies between 18 and 21°B.; the average production is about 300 bbl. per day. There are 80 acres of prospective land belonging to the American Oilfields Co. near the southern boundary at the head of Buena Vista valley which is patented, and also 40 acres of land for which patent is pending, belonging to the Midland Oilfields Co., situated at the south end of the Santa Maria valley, about four miles west of south of McKittrick. Sections 14 and 15 of the Midland Oilfields Co.'s property include 340 acres about four miles east of Hazelton in the Sunset district. There is one well drilling, but upon which work is at present temporarily suspended. Total property of the Midland Oilfields Co. in the Elk Hills and McKittrick Front include 11,370 acres upon which no wells have yet been drilled. Mr. Arnold gives the following summary of probable production:

Tract.	Barrels.
E	7,200,000
F	7,200,000
G	3,297,000
H	78,000,000
I	5,150,000
J	4,000,000
K	30,000,000
L	4,950,000
Total	139,797,000
Production to date	5,161,188
Total probable available supply	134,635,812

The company has a number of contracts including that with the Union Oil Co., Independent Oil Producers' Agency, Golden Gate Portland Cement Co., and Kellogg Oil Co., at advantageous terms.

California electric traction companies have reported for the year ended June 30, 1912, as follows:

San Francisco & Oakland Terminal Ry.:	
Operating revenue	$4,776,873.53
Operating expense	2,892,812.60
Net revenue	$1,884,060.93
San Francisco, Napa & Calistoga Ry.:	
Operating revenue	$189,559.84
Operating expense	105,247.00
Net revenue	$84,312.84
San Jose Railroad Co.:	
Operating revenue	$225,778.11
Operating expense	146,666.37
Net revenue	$79,111.74
Northern Electric Railway Co.:	
Operating revenue	$625,749.48
Operating expense	424,034.53
Net revenue	$201,714.95
Peninsular Railway Co.:	
Operating revenue	$296,618.00
Operating expense	211,860.51
Net revenue	$84,757.49
Petaluma & Santa Rosa Ry.:	
Operating revenue	$304,903.36
Operating expense	202,714.24
Net revenue	$102,189.12
Central California Traction Co.:	
Operating revenue	$302,569.16
Operating expense	214,446.62
Net revenue	$88,122.54
Fresno Traction Co.:	
Operating revenue	$196,261.09
Operating expense	128,642.82
Net revenue	$67,618.27
Humboldt Transit Co.:	
Operating revenue	$117,174.77
Operating expense	73,529.29
Net revenue	$43,645.48
Monterey & Pacific Grove:	
Operating revenue	$41,823.44
Operating expense	26,435.87
Net revenue	$15,387.57
Pacific Electric Ry.:	
Operating revenue	$8,645,504.66
Operating expense	5,750,287.56
Net revenue	$2,895,217.10

Portland (Or.) Railway, Light & Power reports earnings for September 1912 and the nine months ended September 30, 1912:

September gross	$ 542,387
September net	269,565
Surplus after charges	121,245
Nine months' gross	4,918,750
Nine months' net	2,440,483
Surplus after charges	$1,131,951

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San Francisco-Oakland Terminal Railways has reported for the month of October as follows:

	Oct. 1912.
Gross operating revenue	$389,601.40
Miscellaneous income	13,000.56
Gross income	$402,601.96
Operating expenses	241,480.51
Gross income less operating exp.	$161,121.45
Interest, taxes, and misc. charges.	97,348.38
Net income	$ 63,773.07
Surplus for period	$ 63,773.07
Ratio of operating expenses to gross operating revenue	61.98%
Ratio of net operating revenue to gross operating revenue	38.02%

Northern Electric Railway Co. report for the year ended June 3, 1912, shows the following totals:

Operating revenue	$625,749.48
Operating expenses	424,034.53
Net operating revenue	$201,714.93
Bond interest paid, $132,647.74; taxes, etc.	155,933.23
Net income and surplus for year.	$ 45,781.72
Deficit at beginning of year	169,661.13
Deficit at close of year	$123,870.41

Report for the quarter ended September 30, 1912, shows a gain in net earnings over the corresponding period of 1911 of 52.18%. Following is the report:

	July.	Aug.	Sept.
Gross earnings	$67,641.05	$78,139.03	$80,470.71
Expenses	39,477.39	44,915.80	44,554.22
Net earnings	$28,163.66	$33,223.23	$35,916.49

The company has outstanding in the hands of the public $2,070,000 5% bonds and there are $1,717,000 more issued but unsold. These bonds are protected by a capital investment of approximately $8,000,000. The present market price of the bonds is about 95% of their par value. There is also a junior bond issue of $5,275,000 outstanding, of which only about $100,000 is actually in the hands of the public. Of the second issue authorized, amounting to $25,000,000, $3,784,000 is reserved to retire the first-mortgage bonds.

Oregon Electric Railway Co. reports for the year ended June 30, 1912, as follows:

	1912.	1911.
Total operating revenue	$787,476	$616,079
Total operating exp.	480,533	323,512
Net operating revenue	$306,942	$292,567
Taxes	47,440	30,403
Operating income	$259,503	$262,164
Other income	4,278	5,239
Total income	$263,780	$267,404
Interest on bonds	116,483	100,000
Surplus	$147,297	$167,404

The *Spokane, Portland & Seattle Railway Co.* report for the year ended June 30, 1912, compares as follows:

	1912.	1911.
Operating revenue	$4,814,561	$5,453,459
Operating expenses	2,476,258	2,662,122
Net op. revenue	$2,338,202	$2,791,336
Outside operating net	13,094	5,729
Total net revenue	$2,351,397	$2,797,066
Taxes	527,405	470,300
Operating income	$1,823,992	$2,326,766
Other income	1,104,452	726,528
Total income	$2,928,444	$3,053,294
Rents, interest, hire of equipment, etc.	813,331	399,880
Surplus	$2,115,113	$2,653,414

Northern California Power Co., Consolidated, reports for October 1912 as follows:

Gross earnings	$71,516.54
Operating and general expenses	21,260.95
Net earnings	$50,255.59
Maintenance and depreciation	10,510.10
	$39,745.49
Interest on bonds and debentures.	28,106.07
Available for surplus and dividends	$11,639.42

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Book Reviews

ELEMENTS OF DRAWING. By George F. Blessing and Lewis A. Darling. 174 pp., index. John Wiley & Sons, New York. For sale by the *Mining and Scientific Press*, San Francisco. Price $1.50.

This book has been especially prepared for beginners who intend to take a course in engineering or commercial draughting. So many books of similar nature are already available that it would seem to be a difficult task to add anything to the existing literature on the subject. The use and care of the usual instruments, how to sharpen pencils, lettering, draughting room practice, conventional hatchings, free-hand sketching, and isometric projections are all treated at length. The book is copiously illustrated with good line drawings, even to the extent of showing how to make holders for ink bottles. Works of this character are of undoubted value as stepping-stones from a common-school education to more advanced study necessary before a student could become qualified to enter a commercial or engineering draughting-room even as an apprentice.

MACHINE DESIGN: HOISTS, DERRICKS, CRANES. By H. D. Hess. 364 pp., index. J. B. Lippincott Co., Philadelphia. For sale by the *Mining and Scientific Press*, San Francisco. Price $5.

The simplest elements of machine design are required for the larger portion of crane details and are, therefore, common to a wide field of machine design. Stresses, both in the frames and machinery, are readily determined by the elementary principles of mechanics, and the design may thus be easily carried out on a theoretical rather than an empirical basis. This book, as a whole, is intended to aid the work of machine design in technical schools and colleges and should also prove decidedly useful in drawing rooms as a book of reference. The subject matter is subdivided into twelve parts, of which the first covers the general elements of strength of materials and machine design as applied to the various component parts pertaining to hoists, derricks, and cranes. Part II covers frames and girders; Part III, brakes and clutches; Part IV, winches and hoists; Part V, pillar cranes; Part VI, jib-cranes; Part VII, underbraced jib-cranes; Part VIII, inverted post cranes; Part IX, wall-cranes; Part X, overhead electric traveling cranes; Part XI, hoisting engines; and Part XII, locomotive cranes. Taken as a whole, this book has been thoroughly and carefully prepared with exhaustive attention to every detail bearing upon the subject. The work is copiously illustrated with good line drawings and graphic tables, which are of great service for quick calculations. Chapter on hoisting machinery refers to that type of hoist required for crane and derrick service, rather than for larger hoisting engines, such as are used for minning. In the chapter on electric hoists no attempt has been made to go into the details of design of the electrical apparatus itself, outside of a general discussion of the types of motors developed by manufacturers for this purpose and their application to various requirements for cranes and derrick hoists. As a whole this work is excellent and will form a valuable addition to any technical library.

CALIFORNIA STATE HIGHWAY COMMISSION has issued the first number of the California Highway Bulletin, dated October 15. This is a state document for the purpose of presenting authoritative reviews of the work accomplished and forecasts of the plans proposed by the Commission under the State Highways Act of 1909. It is the plan of the Commission to issue the bulletin every two months gratis to anyone interested. The bulletin is exceptionally well prepared and furnishes information of great value to all who are interested in the construction of the $18,000,000 state highway. Subject matter contained in the first number includes freight and material contracts, paving patents, county highway work, specifications of requirements for new bridge trestles and culverts, the opinion of the attorney general concerning routes, and a general summary of the method of organization of the various departments of the Commission. The issuance of this bulletin by the state is a healthy indication of the new order of things in the conduct of government business, and recognizes the right of taxpayers to receive authoritative accounts as to how and for what their money is being expended. To obtain copies of the bulletin regularly, address W. R. Ellis, Forum building, Sacramento, California.

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Engineers' Note Book

Diagram for Weight of Fly-Wheels

*The diagram on the opposite page is based on Goodman's formula, and is a ready method of determining the necessary weight of a fly-wheel to give a desired speed fluctuation. Goodman's formula is—

$$W\omega = \frac{48{,}500{,}000 \times \text{i.hp.} \times m}{N^3\ K\ R\omega^2};$$

where $W\omega$ = weight of fly-wheel in pounds; N = number of revolutions per minute; K = the coefficient of fluctuation; $R\omega$ = the square of the radius of gyration of the wheel; m = a factor depending on the type of engine, cut-off, etc. (See table below.)

VALUE OF m FOR DOUBLE-ACTING STEAM ENGINES.

Cut-off.	Single cylinder....	2 cylinders, cranks at right angles.	3 cylinders, cranks at 120°.....
0.1	0.35	0.088	0.040
0.2	0.33	0.082	0.037
0.4	0.31	0.078	0.034
0.6	0.29	0.072	0.032
0.8	0.28	0.070	0.031
End of stroke	0.27	0.068	0.030

The above are fair average values of m. The diagram affords a ready method of checking them if a speed recorder is available.

The diagram consists of four quarters. The top left hand is the starting point, and will be found to have two sets of figures. The inner 'revolutions per minute' figures correspond to the inner 'horse-power' figures, and the outer to the outer.

The next quarter deals with the radius of gyration of the wheel. For all practical purposes this may be assumed to be the radius of the centre of gravity of the rim.

The bottom right-hand quarter deals with the total percentage speed fluctuations. In order to extend the use of the diagram these may be *multiplied* by 10, the final reading of the weight of fly-wheel being *divided* by a like amount.

The fourth quarter, dealing with the factor m, may be treated the same way, only in this case the weight of fly-wheel would be *multiplied* by 10.

The following example will make clear the use of the diagram:

Required the weight of a fly-wheel to give speed fluctuation of 1% in a 120 i.hp. compound steam engine running at 160 r.p.m., cut-off 0.1, and radius of gyration of wheel 2.5 ft. On reference to the table, m is found to be 0.088. From the point of intersection of the 160-r.p.m. vertical and the 120-i.hp. radial lines follow through horizontals until the 2.5-ft. radius of gyration line is reached. From thence drop vertically downward to the 1% radial line. Then follow the horizontals nearly up to the 0.09 value of m, and drop vertically downward, reading off the weight—2000 pounds.

Rules for Designing Masonry Reservoir Dams

According to F. C. Uren, the following empirical rules for calculations pertaining to the design of masonry dams for reservoirs are based on a comparison of the various classical formulas and a careful study of modern practice and will be found to be simpler in their application than the methods now in vogue.

(1) Under no circumstances should there be any chance of tension on either face.

(2) That the total area of the dam section at any depth x should not be less than $x^2/3$; and for convenience of construction and resistance to shock it must not be much more than this in the upper part.

(3) That $y = 0.7\ x$ up to 100 ft. in depth, $x^{3}/15$. Y equals the offset from a vertical line to outer face in feet, and z equals the offset from a vertical line to inner face in feet.

(4) Z to be calculated as follows. A vertical face, that is z equals zero for heights up to 40 ft.; slope of 1 in 20 and 40 to 80 ft.; 1 in 10 from 80 to 120 ft., and so on, increasing one-twentieth at every 40 feet.

CALCULATIONS made by Rose and Desch indicate that the volatility of zinc depends largely on the coarseness of grain of the metal, and that fine-grained material may be 200 times more volatile than coarser grained.

*Abstract from *Mechanical World*, October 11, 1912.

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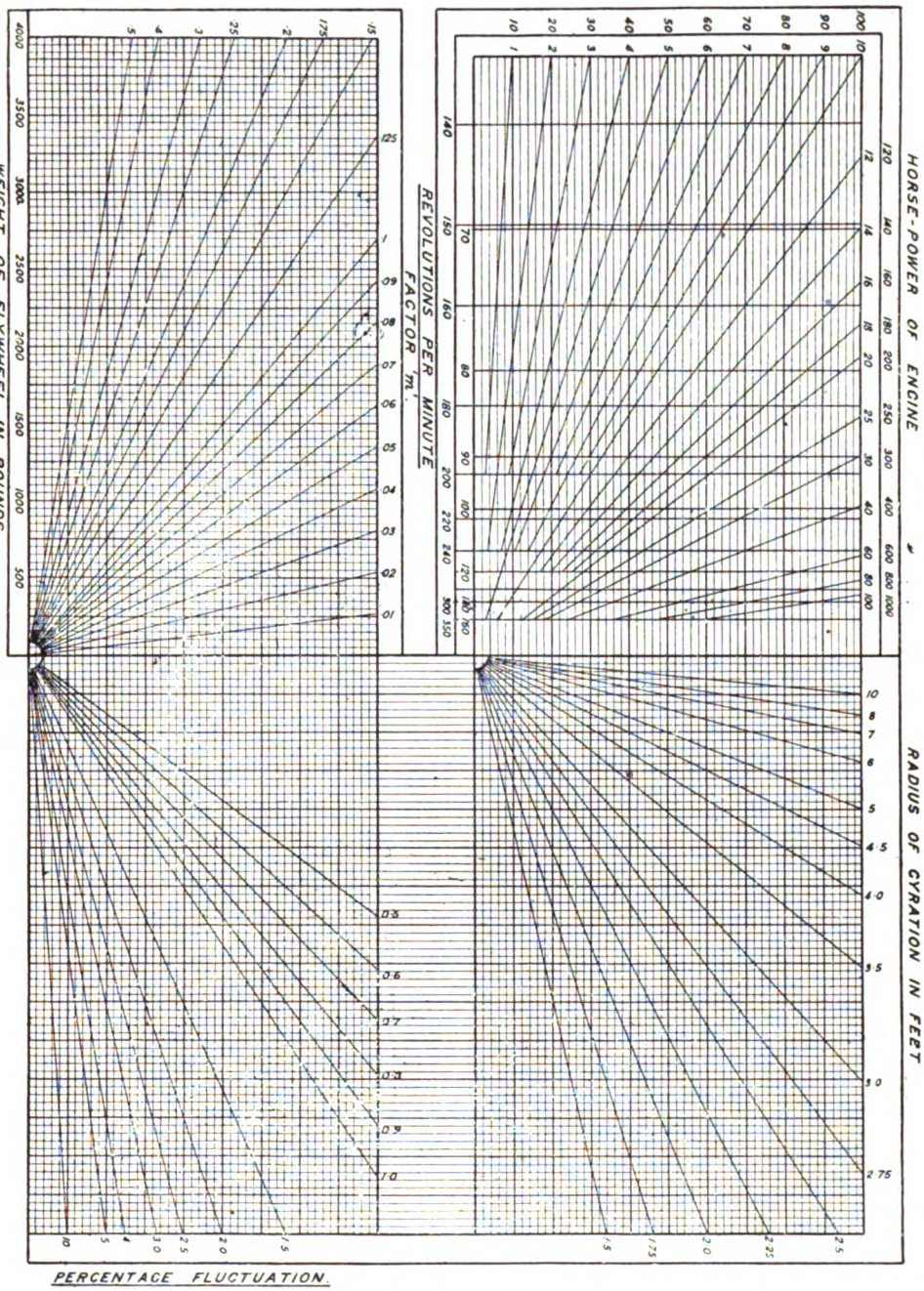

DIAGRAM FOR WEIGHT OF FLY-WHEELS.

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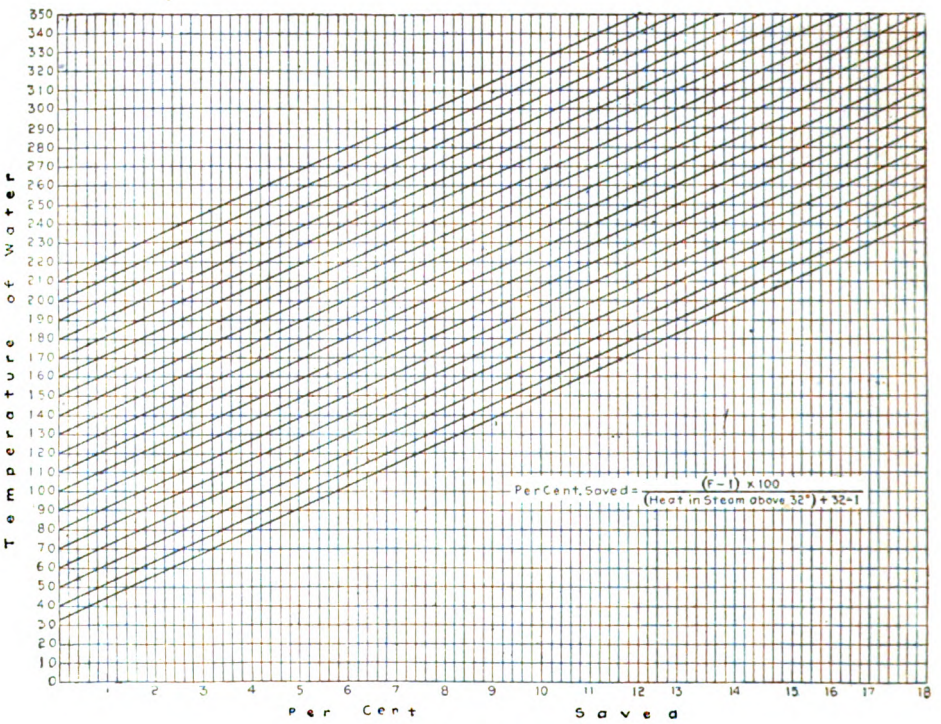
Hints on Practice

Saving by Heating Boiler Feed Water

Every heat unit added to the feed water before entering the boiler which does not come directly from the coal means a saving

To determine readily what percentage of saving may be effected by the installation of apparatus to heat the water, the accompanying chart may be used.



SAVING BY HEATING BOILER-FEED WATER.

It is noticeable that the higher the initial temperature of the water, the greater will be the percentage of saving for a given increase in temperature. For instance, the chart shows that in heating the water from 50 to 100°F. there is a saving of 4.3%, and that in heating it from 150 to 200° a saving of 4.7% is made.

To use the chart, read horizontally from the final temperature of the water to the diagonal line leading from the initial temperature, and then vertically downward to percentage scale. This chart is calculated for 100-lb. boiler pressure. For 50-lb. pressure, percentages are less than 0.15 higher. For 200-lb. pressure percentages are less than 0.2 lower.—*Power.*

Periodical shipments of large quantities of cement shingles are received in Mexico. They come from England and are being used quite extensively in certain districts, being shipped mostly to the city of Mexico, which seems to be the distributing point. These shingles are made of cement mixed with cotton fibre, and are nailed on the same as wooden shingles. The nails will drive readily through them without any damage, the hole closing tightly about the nail. A large tin washer is used to make it more secure against leaks.

Rosendale cement is made from a limestone rock containing in its native state, or otherwise having added to it in the form of clay, about 30% of silica, 8% of alumina, 3% of iron oxide, 33 to 35% of lime, and the remainder magnesia.

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Personal

N. S. DARLINGTON, of the State Highway Commission, is in San Francisco.

PHILIP MCRAE, an oil operator of Hanford, was in San Francisco on November 13.

E. L. DOHENY, an oil operator of Los Angeles, spent a few days in San Francisco last week.

O. B. STEEN, of Los Angeles, has been elected a director of the Pacific Pipe-Line Company.

H. A. JASTRO, an oil operator of Bakersfield, has returned after a brief visit in San Francisco.

D. J. DESMOND, chief commissary of the Los Angeles aqueduct, is spending a few days in San Francisco.

J. M. JAMESON, who is interested in oil properties in the Kern River district, has returned to Bakersfield.

S. A. JUBB has been appointed assistant city engineer in charge of harbor work in the city of Los Angeles.

A. D'HEUR, general manager for the Kern Trading & Oil Co., has returned from an extensive European trip.

W. G. REESE, who is interested in oil properties in the vicinity of Bakersfield, was in San Francisco last week.

SAMUEL STORROW, consulting engineer from Los Angeles, has reported on the water supply for the city of Monrovia.

R. F. MARTIN, representing the English owners of the Pacific Pipe-Line Co., has sailed from New York for London.

CHARLES KIRBY FOX, of Fort Bidwell, California, spent a few days in San Francisco during the first part of November.

J. A. BARR has been appointed manager of the Bureau of Conventions and Societies for the Panama-Pacific Exposition.

E. D. VINCENT, assistant city engineer of Los Angeles, has been detailed to assist in the San Pedro harbor development.

B. K. STROUD, superintendent for the Universal Oil Co., of Wasco, California, spent a few days in San Francisco the first part of November.

M. M. O'SHAUGHNESSY, city engineer of San Francisco, and J. H. DOCKWEILER, consulting engineer, have accompanied Mayor ROLPH to Washington, D. C., to take up the matter of the revocation of the Hetch-Hetchy water-supply permit.

J. W. FRANK, T. B. EDDINGTON, J. J. MADIGAN, M. ROSENCRANTZ, and F. F. HAWLEY have been elected directors of the Midas Petroleum Company.

FREDERICK H. NEWELL, Chief of the U. S. Reclamation Service, delivered a lecture to the students at the University of California on November 12.

JOHN COFFEE HAYES, manager of the Mount Whitney Light & Power Co., accompanied by L. D. STOVALL, chief engineer, was in San Francisco on November 7.

D. W. SHANKS, of Los Angeles, stopped in San Francisco for a few days on his way to inspect his lumber and mining interests in the northern part of the state.

C. H. MCKINSTRY, chief engineer of the U. S. Hydrographic Office, has been inspecting the Los Angeles aqueduct accompanied by J. B. LIPPINCOTT, assistant chief engineer.

GEORGE N. RANDLE, superintendent of streets at Sacramento, and formerly city engineer, has resigned his position to become general manager of the Sutter Basin reclamation project.

Gen. WILLIAM H. BIXBY, Chief of the Engineering Corps, U. S. Army, has been inspecting Sacramento and San Joaquin river improvements, accompanied by Maj. S. A. CHENEY.

W. B. FREEMAN, formerly of Denver, has accepted the position of irrigation engineer for the Siamese Government, with headquarters at Bangkok, Siam, and will report there about January 1.

JOHN M. ESHLEMAN and MAX THELAN, of the California State Railroad Commission, have gone to Washington, D. C., to attend the session of the National Convention of Railway Commissioners.

HOWARD C. HOLMES, formerly chief engineer for the State Board of Harbor Commissioners, has been appointed consulting engineer for dock and waterfront construction for the Panama-Pacific Exposition.

WILLIAM T. MADDIX has resigned his position as superintendent of the southern division of the Pacific Electric Railway system to become assistant general manager for the Utah Light & Railway Co. at Salt Lake City.

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Society Meetings

The Engineers' Club of San Francisco held a meeting at the Palace Hotel on Tuesday, November 12. The same officers and directors were elected who held office prior to incorporation. A movement is under way to provide the Club with permanent headquarters.

The Utah Society of Engineers held its regular session at 702 Newhouse building, Salt Lake City, on November 15. The subjects discussed and papers read included: 'Hydro-Electric Power Resources Tributary to Salt Lake City,' by H. D. Randall, of the General Electric Co.; 'Factors Determining Cost of Hydro-Electric Service,' by Markham Cheever, of the Telluride Power Co.; 'Continuity of Hydro-Electric Power Service,' by Leonard Wilson, consulting engineer; 'An Example of Modern Transmission Practice,' by L. J. Riter, of the Utah Light & Railway Company.

Recent Publications

BULLETIN 46. An investigation of explosion-proof motors, by H. H. Clark. 44 pp., ill. Bureau of Mines, Washington, D. C., 1912.

TECHNICAL PAPER 28. Ignition of gas by standard incandescent lamps, by H. H. Clark. 4 pp. Bureau of Mines, Washington, D. C., 1912.

TECHNICAL PAPER 25. Methods for the determination of water in petroleum and its products, by I. C. Allen and W. A. Jacobs. 13 pp. Bureau of Mines, Washington, D. C., 1912.

BULLETIN 43. Comparative fuel values of gasoline and denatured alcohol in internal-combustion engines, by R. M. Strong and Lauson Stone. 243 pp., ill. Bureau of Mines, Washington, D. C., 1912.

E. H. ROLLINS & SON are issuing a magazine known as *Rollins' Magazine*. It is a quarterly publication, of which the July and October numbers have been received. The publication is intended primarily for the general information of investors in bonds and other high-class securities. The subject matter is presented in an interesting and instructive manner and should prove decidedly beneficial.

Catalogues Received

NORDBERG MANUFACTURING CO. has issued bulletins No. 20 and 21, describing 'S.C.' belted type compressors and the Nordberg 'Uniflow' Corliss type engine. These bulletins contain descriptive matter, foundation plans, and general information of value to engineers and purchasing agents.

The BYRON JACKSON IRON WORKS has issued 'Bulletin No. 5,' describing the Jackson 1912 direct-connected centrifugal pump. This bulletin is very complete and goes into details describing the construction and adaptability of this particular type of pump, and also contains valuable engineering data concerning friction of water in pipes, irrigation, and directions for installing and starting. Foundation and setting plans giving over-all dimensions and space occupied are also included.

The GOLDSCHMIDT THERMIT CO., Pacific Coast branch, 432 Folsom street, San Francisco, has issued a bulletin covering instructions for the use of thermit in railway shops, and another covering marine and general repairs. These bulletins contain a great deal of valuable information and illustrate and describe a number of concrete examples showing the variety of applications of this interesting method of welding.

Commercial Paragraphs

The WESTINGHOUSE ELECTRIC & MANUFACTURING CO. has delivered the first one of the fifteen electric locomotives ordered by the Pacific Electric Railway Co. of Los Angeles. The 60-ton locomotive will be used principally to operate freight and passenger trains on the interurban lines running out of Los Angeles.

RALPH A. GOULD, formerly chief of the San Francisco Food & Drug Inspection Laboratory of the U. S. Bureau of Chemistry; Edward E. Free, formerly with the U. S. Bureau of Soils in field potash investigations; and Charles S. Ash, formerly chemist and assistant superintendent of the California Wine Association, announce their association under the firm name of GOULD, FREE & ASH, Chemical Engineers, with offices in the Monadnock building, San Francisco.

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Engineering News

Railways

San Francisco.—The Board of Supervisors has voted to grant the United Railways a revocable permit to operate street-cars along Bay and Laguna streets in order that an extension of the Polk and Larkin line may be operated through the Government military reservation at Fort Mason to the transport docks. The conditions imposed by the city are that the United Railways pay to the city the percentage of gross receipts provided for in the charter on a trackage basis. The Secretary of War has already granted the necessary permit for passage through the military reservation on condition that the city grant the necessary revocable permit for the tracks over the city streets. Bion J. Arnold is consulting traffic expert for the city and will draw the necessary permit.——Western Pacific Railroad Co. has commenced construction of a new ferryboat at its Oakland yards. The boat will be entirely of steel excepting the housings. Superstructure will be built of wood, finished inside with mahogany. The vessel will be 230 ft. in length, 62 ft. 6 in. beam, and 19 ft. in depth, and will be driven by fore-and-aft propellers. A. H. Powell is master mechanic.——The Nevada-California-Oregon railroad is planning to add a third rail to its present narrow-gauge line from Reno to Doyle. At Doyle and Reno cars are to be switched to the Western Pacific tracks and run through to San Francisco without change. Consummation of this traffic agreement between the two railroads will give San Francisco another rail entry into Reno. F. F. Dunaway is vice-president and general manager of the Nevada-California-Oregon road. The total distance to be standard-gauged is approximately 100 miles.——Agreements have been drawn up for the sale of 800,000,000 ft. of timber in the Chiquita basin, in the Sierra Forest Reserve, belonging to the United States Government, to the Sierra Sugar Pine Lumber Co., which, it is understood, is controlled by the E. L. White Lumber Co.'s interest with offices in the Balboa building, San Francisco. It is estimated that the price which the Government will ultimately receive for the sale of this timber is approximately $1,700,000. It will be necessary to build a railroad into the forest in order to bring the timber out. It is understood that negotiations are in progress with the Southern Pacific Co. and also with the Pacific Light & Power Co. for the extension of their lines into the lumber camps. Frank Drew, of San Francisco, was attorney for the Sierra Sugar-Pine Lumber Co.——Financial statement for the Ocean Shore railroad for the period beginning December 1, 1911, and ending November 1, 1912, shows that the company has a net surplus of $22,000 on hand, the net for October of this year alone aggregating $9051.04. F. W. Bradley, of San Francisco, has been elected president, Alfred Williams, vice-president and general manager, J. W. Crosby, secretary and treasurer.——Chairman of the Public Utilities Committee of the Board of Supervisors has announced that the cars will be running on the Geary street municipal railway by the middle of December.——Lumber schooner *William H. Chatham* for the Loop Lumber Co., has been launched from the ways of the Union Iron Works. The new vessel is a steam schooner, steel construction throughout, and is 235 ft. long, 42½ ft. wide, and has a draft of 18½ ft. She is to be equipped with two Scotch marine boilers to furnish steam for operating a triple-expansion engine which will develop 1230 hp. Maximum speed of the vessel is 12 knots per hour; the full-load speed being 10½ knots per hour. The cargo-carrying capacity is 1,500,000 ft. of lumber. The vessel has been designed by H. P. Frear, of the Union Iron Works, and N. Levison, of the Loop Lumber Co.——The Southern Pacific Co. has commenced work of grading the entire right-of-way between Elmhurst and Niles for laying a double track.

San Jose.—The California Central Railroad is about to extend its lines from Hollister to Watsonville. A present trackage now extends from San Juan to Chittenden, where it connects with the line of the Southern Pacific Co. This road is used principally by the Old Mission Portland Cement Co., of which J. C. Kemp Van Ee is president. Report that the railroad company has been absorbed by a larger company has been denied.

Berkeley.—Southern Pacific Co. has notified the Railroad Commission that it will commence work at once on the construction of a new depot at Third street and University avenue, in accordance with the order of the Commission issued September 21.

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The cost of the new depot will be approximately $15,000 and plans have been submitted to the Commission.

Antioch.—Preliminary work on the construction of the Chipps Island bridge was commenced on November 21, when four pile-drivers and a large force of men were put to work. A slip for a large ferryboat will also be constructed and plans have been prepared. It is stated that three years' time will be required for completion of the bridge. Until it is completed ferryboats will be employed.

Sacramento.—It has been stated that the Vallejo & Northern Railroad has secured an option on property at Third and I streets for the purpose of constructing a union electric depot.

Valley Springs.—W. B. Clark, of Valley Springs, and C. A. Westenberg, of San Francisco, are reported to be endeavoring to interest capital for the construction of an electric railroad from Valley Springs to Mokelumne Hill. Surveys have already established the grades for the road via the marble quarry of which Mr. Clark is proprietor.

Los Angeles.—Specifications for the municipal railroad on San Pedro street from Aliso to Ninth have been submitted to the city engineer. The Public Utilities Board has decided to call upon the Pacific Electric Co. to construct all turnouts, crossings, and intersections on the road at its own expense. P. W. Stewart is city engineer in charge of this construction.

San Pedro.—Los Angeles & Salt Lake Railroad has placed an order for 300 freight cars at a cost of $1100 each. These cars will have steel under-frames and will be 40 ft. long. H. C. Nutt is general manager.——The estimated cost of the San Pedro municipal street railroad has been placed at $208,520 by Homer Hamlin, city engineer. This is equivalent to a trifle under $29 per lineal foot. Payment for the road is to be made in installments of $10,000 on completion and the balance on December 1, 1913, provided 35 days have elapsed between that time and the first payment. A time limit of eight months has been placed for the completion of the contract, and 40 days will be allowed after securing contract in which to begin work.——The Southern Pacific Co. has announced plans for the construction of a new depot to be built over the present Arcade station which will then be torn down. It will be 600 ft. long, 70. ft. wide, and 60 ft. high, and will cost when completed $750,000. Gray sandstone will be the material used for walls. Cream and pink marbles will adorn the interior. The type of architecture will be Italian Renaissance, while Tuscan columns will support the roof. The station will contain 12 tracks, with an individual umbrella shed. It will extend to Central avenue and necessitate the removal of several old hotels now occupying ground at the station approach. Work will commence within six weeks and the entire structure will be completed within 18 months. H. V. Platt is general superintendent and H. V. Titcomb is district engineer. The architects are Parkinson & Bergstrom of Los Angeles.

San Bernardino.—It has been announced that the Santa Fé railroad will expend $978,000 on 10 miles of track extending from Summit to Kernbrook in Cajon pass, in order to cut eight-tenths of 1% from the heavy grade on its line through the San Bernardino mountains. Survey for the work is completed and preliminary contracts have been let. Two tunnels are to be constructed near Summit, and there are deep rock cuts through the sides of the canyon and several miles of concrete protection work to be built. It is estimated that one-third of the motive power on freight transportation over this track will be eliminated by the improvement.

Orland, Glenn county.—A force of engineers of the Northern Electric Co. are running a line west of Orland and Newville. While a definite announcement of the company's intentions has not been made, it is said that it contemplates extending its line from Chico and Hamilton City west as far as Newville.

Twin Falls, Idaho.—The Oregon Short Line will build a line from Twin Falls to Wells, Nevada, where it will connect with the Southern Pacific. W. H. Bancroft is general manager. Surveys to Wells are already in progress.

Portland, Oregon.—At a meeting of the directors of the Portland Railway, Light & Power Co., resolutions were adopted calling for an assessment of 5% or $5 per share on the stock of the company from stockholders of record on November 16, the assessment to be paid by December 2. A resolution was also adopted providing for a special dividend of $5 per share, not to be paid in cash, but

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to be credited to stockholders at the time of payment of the 5% cash assessment on December 2, as an additional payment on account of the amount remaining unpaid on their stock, making it 75% paid.

Salt Lake City, Utah.—Negotiations are under way for the sale of the Salt Lake & Ogden Electric Railway to Eastern interests represented by M. B. Hereley, of Chicago.

Denver.—Vice-President Brown, of the Denver & Rio Grande Railroad, has awarded to the Utah Construction Co. of Ogden, Utah, contract in the sum of $1,500,000 for the grading of the new double-track detour line over Soldier Summit, where the railroad crosses the Wasatch range in Utah. This change involves the building of 15 miles of new line and reduces the grade from 4 to 2%. Construction will commence at once, and contract calls for completion August 1, 1913. The work will be very heavy and will include one tunnel 255 ft. long. There will be no bridges, but numerous concrete arches. The new line will be laid with 90-lb. steel rails, rolled at the plant of the Colorado Fuel & Iron Co. at Pueblo, Colo. The track will be ballasted with Jordan Narrows gravel.

Victoria, B. C.—The Canadian Pacific Railway has awarded contract to Moore & Pethick, of Victoria, for grading 20 miles of E. & N. extension along the Vancouver Island east coast. This section is between a 10-mile contract now under way by C. E. Hoard of Victoria south from Union bay, a 15-mile contract now under way by Culliton Brothers of Spokane, north from McBride Junction near Nanaimo. This work is to be completed by July 1, 1913.

Power, Gas, and Electricity

San Francisco.—The Pacific Gas & Electric Co. is employing over 1500 men on the Lake Spaulding power project. The nearest railroad station is Smart, on the line of the Southern Pacific Co. The reservoir storage capacity has a surface area of about 700 acres, and a storage capacity of approximately 40,000,000,000 gal. The watershed tributary to the reservoir will discharge 60,000,000,000 gal. annually. The rock for the concrete dam will be quarried out of the bluff overtopping its southerly abutment. The reservoir site has on it about 1,000,000 ft. of saw timber, all of which will be utilized for the construction work. The reservoir outlet will be a concrete tunnel 4427 ft. long. This tunnel will conduct the water to the upper end of the concrete-lined canal 8½ miles in length, which will have a capacity of 16,000 inches. The canal will conduct the water to a point known as the Drum forebay, about 3 miles northeast of Towle station. Two riveted steel pipes 6300 ft. long and 72 in. diameter at the upper end will conduct the water from the forebay to the power station 1350 ft. lower. Eight water-wheels will be installed having a capacity of 9000 hp. each. The water-wheels installed will have nozzles 7 in. diameter and the working pressure will be 585 lb. per square inch. Power generated will be transmitted over a double circuit steel tower line 115 miles to the sub-station at Cordelia, Marin county. It is estimated that two years will be required to complete the construction of the entire project, and that, including the power possibilities for additional power lines farther down the line of the Bear river, upward of 100,000 hp. will ultimately be developed for this project.—San Joaquin Light & Power Corporation has reported for October and ten months:

	Oct. 1912.
Gross income	$125,774.95
Operating expenses, maintenance, and taxes	44,216.45
Net income	$81,558.50
Interest charges and sinking fund	39,226.72
Net surplus	$ 42,331.78

	10 Mo. Endg. Oct. 31, 1912.
Gross income	$1,097,132.86
Operating expenses, maintenance, and taxes	438,797.83
Net income	$ 658,335.03
Int. charges and sinking fund	370,829.68
Net surplus	$ 287,505.35

Los Angeles.—The Railroad Commission has ordered reduction in light rates in southern California which will affect 27,000 consumers, thereby causing an annual saving of $104,000. The cities affected are Pomona, Claremont, Lordsburg, Redlands, Monrovia, Inglewood, Chino, Sierra Madre, Whittier, Santa Monica, Venice, Sawtelle, Redondo Beach, Hermosa Beach, Santa Ana, Orange, Fullerton, South Pasadena, and Alhambra. The maximum rate of 10c. per

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kilowatt-hour heretofore collected by the Southern California Edison Co. has been reduced by the Commission to 8c. per kilowatt-hour. The new rates go into effect January 1, 1913.——The Economic Gas Co. has petitioned the City Council for a blanket franchise to lay pipes in the city streets.——The Pacific Light & Power Corporation has filed application with the Railroad Commission for permission to purchase the electric distributing system of the Eagle Rock Water Co. of Los Angeles county for $22,500, and has also asked permission to extend its electrical system into the city of Eagle Rock. ——The Railroad Commission has granted permission to the West Coast Gas, Light & Fuel Co. and the Home Gas & Electric Co. of Newport Beach, Orange county, to consolidate and issue new securities. The consolidated corporation is to be known as the West Coast Gas Co. and is permitted to issue stock in the amount of $91,075 and bonds in the sum of $100,000.——The Pacific Telephone & Telegraph Co. has applied to the State Railroad Commission for permission to purchase the outstanding stock of the San Gabriel Valley Home Telephone Co. with headquarters in Alhambra, Los Angeles county.——The president of the Public Utilities Board has indicated that the 41c. rate for maintenance and distribution at present charged by local gas companies within the city will be materially reduced in the near future. President Foulkes has pointed out that the Southern California Co. is ready to carry natural gas to the city limits at a cost of 18c., and that if the 41c. distribution and maintenance rate at present charged is permitted to hold, the Southern California Co.'s product will sell at a rate of 60c. to the consumer.——According to W. E. Dunn, president of the Midway Gas Co., in his testimony before the Railroad Commission, three companies will be required to handle natural gas before it can be turned into the mains of the city distributing systems. Mr. Dunn says, in effect, that the Honolulu Oil Co. produces the gas and agrees to sell it south of the Buena Vista hills in the Midway field at a pressure of 450 lb. per square inch for 8c. per 1000 cu. ft. The Midway company is to transport the gas through a 12-in. main to a point on the Fernando road north of Los Angeles, where a reducing station will transfer it to a main 3½ miles long owned by the Southern California Gas Co. The Midway company is to receive 5c. per 1000 cu. ft. for receiving the gas and distributing it to the other companies in the Los Angeles field; thus the cost of gas to the city limits will be 18c. per 1000 cu. ft.——The Imperial Gas Co., which operates in the Imperial valley, has filed a supplementary application with the Railroad Commission asking for authority to issue $200,000 in bonds for the purpose of discharging outstanding obligations and for betterments in the form of new gas mains and distributing systems in cities in the Imperial valley.

Venice.—The Venice city trustees have instructed the city attorney to provide an ordinance fixing the electric light rate at 3½c. per kilowatt-hour. An ordinance for an 80c. gas rate has been adopted and goes into effect at once. This cuts the rate from $1.15 per 1000 cu. ft.——An ordinance calling for a special election to vote $170,000 in bonds is to receive special consideration at the meeting of the Board on December 1. These funds will be used for the purchase of a municipal water-supply plant.

Port Angels, Washington.—Reports that the new dam on Elwha river belonging to the Olympic Power Co. has been washed out have been denied. A severe flood occurred on October 30, but the dam itself is intact and was not even cracked. The cost of repairing injuries to the power-house and of extending the dam to bedrock will not exceed $150,000. The washing out of the silt in the river beneath the dam is said to be a benefit to the builders, who will not be obliged to remove the earth and stones. The farmers below the dam had been warned of impending danger and fled to the hills when they heard the roar of the water.

Boise, Idaho.—I. B. Perrine, of Twin Falls, is conducting negotiations for the construction of a scenic railway from the town of Twin Falls to Shoshone Falls on the Snake river. It is expected that the first excursion to Shoshone Falls will take place about December 1. The electric cars used wil be of the Edison storage-battery type. The railroad is in the form of a loop, approximately 10 miles long. It runs from Twin Falls for three miles along the bank of the Snake river canyon, then south two miles and west three miles back to Twin Falls. Condemnation proceedings have been instituted against the state of Idaho to acquire the rights of way on both sides of the Snake river.

Salt Lake City, Utah.—Suit to prevent the

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sale to the city of the Telluride Power Co., filed by L. L. Nunn, has been withdrawn, a settlement made, and the properties sold at sheriff's sale. This clears away the last obstacle in the way of the consolidation of the many hydro-electric and steam power-plants known as the Utah Power & Electric Light Co., of which D. C. Jackling will be president. The assets of the Telluride Power Co. were bid in at $6,460,000, the only bid being made by W. E. Wheeler, of the Bank of Telluride. He was acting for Neal A. Withers.

Los Gatos.—The town of Los Gatos has called for bids on 100 municipal improvement bonds of the denomination of $810 each which bear interest at the rate of 5% per year from January 1, 1913.

Streets and Roads

Sacramento.—Actual building of the system of state highways provided for by the $18,000,000 bond issue under the California Highway Commission is proceeding with dispatch. There are 152 miles of highway actually under construction, including portions in fourteen counties. The greater part of the road under construction is of hydraulic concrete with oil surface. The amount and type of road under actual construction in the various counties is as follows:

County.	Type.	Mileage.
Mendocino	graded	12.8
San Mateo	asphalt concrete	5.4
Ventura	trestle mostly	4.4
San Diego	oil concrete	8.4
Sacramento	oil concrete	1.8
Placer	oil concrete	9.9
Yuba	oil macadam	8.9
Stanislaus	oil concrete	11.1
Merced	oil concrete	20.5
Madera	oil concrete	16.7
Madera	oil macadam	10.0
Fresno	oil concrete	9.6
Santa Clara	oil concrete	5.5
Santa Clara	oil macadam	6.5
Sonoma	oil concrete	14.0
Los Angeles	oil concrete	6.6

Specifications for 72 miles more of highway have been completed. The additional mileage to be constructed is distributed in the following counties: San Luis Obispo, from San Luis Obispo to Santa Marguerita, 6.1 miles; San Diego, from Encinitas to Oceanside, 10 miles; Monterey, 7.5 miles; Mendocino, 6.5 miles; Merced, 14 miles; Butte, 11 miles; Stanislaus, 7 miles; Santa Clara, 13 miles; San Mateo, 3.4 miles. Surveys have been completed for 2300 miles of highway in all. Counties have provided or have promised to provide bridges and rights-of-way of an aggregate estimated value of $4,000,000 for the state system, which will bring the total outlay to $22,000,000 when the system will have been completed. The State Highway Commission has recently signed a contract for approximately 500,000 tons of crushed rock with the Natomas Consolidated of California. This rock will be furnished from the three crushing plants of the company, operating at Natomas, Fair Oaks Bridge, and Oroville.

A summary of bids for various sections of state highway opened on November 18 is as follows:

San Luis Obispo county; Div. 5, Route 2, Sec. D:

State Construction Co., S. F.	$61,196.60
Engineering & Construction Corp.	52,961.00
Sandercock Trans. Co., S. L. Obispo	63,661.40
State estimate	46,282.56

Santa Clara county; Div. 4, Route 2, Sec. B:

State Construction Co., S. F.	$53,616.70
E. B. Burge, Sacramento	49,590.50
City Street Imp. Co., S. F.	67,836.25
A. Trichert & Son, Sacramento	73,126.75
F. W. Wehner, San Jose	59,770.20
McGillivray Con. Co., Sacramento	52,424.40
Ransome-Crummey Co., Oakland	50,291.05
Richard Keating & Sons, S. F.	49,296.75
John F. Adams, San Jose	40,840.75
State estimate	55,584.45

Butte county; Div. 3, Route 3, Sec. D:

Moreing & Moreing, Stockton	$66,717.00
Geo. W. Martin & Son, Sacramento	60,632.40
Engineering & Contr. Corp., S. F.	72,536.00
Richard Keating & Sons, S. F.	62,250.40
McGillivray Const. Co., Sacramento	67,673.40
Chico Construction Co., Chico	69,940.50
State estimate	52,632.63

Merced county; Div. 6, Route 4, Sec. A:

Moreing & Moreing, Stockton	$64,256.25
E. O. Burge, Sacramento	55,362.00
McGillivray Construction Co.	69,829.00
Ransome-Crummey Co., Oakland	52,753.55
Worswick Street Paving Co, Fresno	65,757.50
Richard Keating & Sons, S. F.	61,434.55
J. M. Montgomery, Alhambra	55,220.75
State estimate	54,530.12

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San Diego Co.; Div. 7, Route 2, Sec. B:

Gillette, Montgomery & Tracy, So. Pasadena	$59,444.10
John D. Marsh, Los Angeles	57,929.15
Leigh G. Garnsey, Los Angeles	64,314.42
J. M. Montgomery, Alhambra	56,715.30
Engineering & Const. Corp, S. F.	53,991.00
Rogers Bros. Co., Los Angeles	68,371.00
Knight & Hyde Con. Co., San Diego	62,869.00
M. S. & C. G. Cummings, Los Ang.	*79,610.00
F. F. Prendergast, Los Angeles	72,004.65
State estimate	60,311.29

*Irregular.

San Mateo Co.; Div. 4, Route 2, Sec. B:

City Street Imp. Co., San Francisco	$42,033.50
S. P. Doyle, San Francisco	41,720.50
Flinn & Tracy, San Francisco	49,195.75
Ransome Crummey Co., Oakland	44,468.50
State estimate	43,439.70

Mendocino Co.; Div. 1, Route 1, Sec. C:

David L. Sawyer, Willits	$33,274.46
Fairbanks & Baechtel, Willits	29,957.50
Engineering & Const. Corp., S. F.	34,475.75
State estimate	35,457.09

Award of all contracts has been postponed.

Alameda.—Board of Public Works has awarded a contract to the Barber Asphalt & Paving Co. for asphalting and constructing storm drains and macadamizing Alameda street from Seventh to Twenty-first. Work is to be completed within 240 days. The total amount involved is $71,635.63.

Los Angeles.—City Engineer Homer Hamlin has advised the relaying of roadway on South Main street from Tenth to Jefferson streets.

Santa Monica.—The city of Santa Monica is planning to spend $750,000 for street improvements. This will include the construction of Santa Monica boulevard, Fremont avenue, San Vicente boulevard, and extensions to the ocean front promenade and six other streets. Contract has been let to the P. N. Snyder Co. of Los Angeles for Santa Monica boulevard, the amount of the contract being approximately $200,000. Eight months will be required to complete this work.

Santa Ana, Orange county.—The city of Santa Ana has voted in favor of additional good roads to be provided for by issuing bonds in the sum of $1,270,000, the majority being more than two to one in favor of the issue.

Placerville.—The Board of Supervisors has passed a resolution granting all rights-of-way and agreeing to build all bridges along the state highway through this county free of cost to the state.

Spokane, Washington.—Work has commenced on a survey for the new $100,000 highway which is to be built next year and will extend from Regal street in Spokane to Freeman on the Moran prairie, a distance of 20 miles. Connection will be made later from this point with Fairfield, Rosalia, and Rockford. Preparations are also under way to survey a 20-mile extension to the Mead and Graves roads. C. L. Graves is county engineer.

Moscow, Idaho.—A contract has been awarded to Bird & Mendenhall Construction Co., of Salt Lake City, for 'Dolarway' paving for the sum of $123,390. A bid of $2.05 has been made for 'Bitulithic' on a 5-in. concrete base, $1.75 on a bituminous base. Asphaltic concrete and 'Bitumass' also had bids ranging between $1.70 and $1.80 per yard on a 5-in. base with a 2-in. wearing surface. The 'Dolarway' bid on a 5-in. base was $1.23 per yard with a 5-year bond for $400 per year for 70,000 yards. The difference in cost to the property-owners of the district amounted to $54,000. A storm-sewer system, grading, and curbing is also included in the contract.

Irrigation and Water Supply

San Francisco.—The State Supreme Court, in a decision rendered on November 20, has decided, in effect, that the large irrigation companies of the state may condemn private water rights even when the water to be taken is not to be supplied to all inhabitants of a village, town, city, or county. The court decided further that public use within the meaning of the statute signifies use by a numerous enough portion of the population to render it not a private use. The decision is for the San Joaquin & Kings River Canal & Irrigation Co. and against James J. Stevenson.——The Railroad Commission has granted permission to the Lake Hemet Water Co., the Fairview Light & Water Co., the Hemet Town Water Co., W. F. Whittier, and W. S. Pelbout to sell their water properties in southern California to the Southern California Utilities Co. for the sum of $4,417,992. This is part of the transaction under which the Southern California Utilities Co. proposed, under the bond issue of $10,000,000, to develop extensive land holdings in Riverside county and to engage in

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irrigation and hydro-electric power generation.——The Natomas Consolidated of California has entered into a contract with the Oro Electric Corporation for all the power it requires, and in addition a contract has been signed in perpetuity for 10,000 inches of water to be delivered to the agricultural lands of the Natomas company.

Sacramento.—A Chicago syndicate, represented by W. E. Gerber, of this city, is reported to have closed options on the entire unreclaimed portion of the lower end of Sutter basin, embracing over 60,000 acres. Mr. Gerber is president of the California National Bank. The direct representative of the Chicago interests was R. J. Dunham, and it is rumored that J. Ogden Armour is back of the project. It has been announced that no definite improvements will be undertaken until February 1, 1913, while careful soil and engineering investigations are to be made, and that ultimately the land will be entirely reclaimed and placed under cultivation.——The American River Reclamation district has applied to the State Reclamation Board for permission to form a district across the American river from the city of Sacramento and to construct a river levee so as to provide for a 1500-ft. channel for the river. City Engineer Albert Givin and Consulting Engineer C. E. Grunsky furnished reports in regard to flood and rainfall on the American river and American watershed that would indicate the necessity for changing the entire plan of flood control on the American and Sacramento rivers. It is likely that in view of the fact that the flood of 1861 and the rainfall preceding it were greater than the flood of 1907, that the carrying capacity of the proposed by-pass must be increased by at least 60,000 second-feet.——The Netherlands Farm Land Co. has made application before the Board for the right to erect levees. This project covers 25,000 acres of extension from District No. 900 to Tyer island. H. W. Furlong, manager, and F. H. Tibbetts, engineer, presented the application.

Los Angeles.—The completion of the Yuma siphon was celebrated by the people in the affected district on November 17. This siphon has taken three years in construction and will supply water for irrigating 130,000 acres. The siphon is 900 ft. in length and 40 ft. below the river bed; inside diameter is 14 ft.; the walls of concrete are 2 ft. in thickness. The water passing through the siphon is conducted via the main canal, which is 80 ft. wide at the bottom and 120 ft. wide at the top, and 10 ft. in depth, along the upper portion of the valley where it is separated into two channels. Provisions have been made for installing a pumping station for supplying 40,000 acres of mesa land. Francis E. Sellew has been engineer in entire charge of construction work for the Government on the Yuma project since 1906.——The city of Los Angeles has acquired the plant of the San Pedro Water Co., the purchase price to be paid to the company is $125,000.——The Mutual Water Company of Azusa has had a conference with Frank G. Henderson, president of the Water Board; as a result the company has agreed to pay $50,000 to the city of Los Angeles within the next few days. This makes it possible for the Water Board to commence work on the water distributing system before the proposed bond issue of $8,400,000 has been voted upon by the people of this city. The money will be devoted to the construction of that part of the distributing system which is to supply the San Gabriel valley with Owens river water.——The Water Board has decided upon a rate of 2c. per miner's inch per hour for Los Angeles aqueduct water used for irrigation purposes. For the average irrigated crop of orchard one miner's inch will cover 7½ acres per year. The older citrus orchards require somewhat more, while forage and hay crops require somewhat less. At this rate the water will cost irrigators $233 per year for each acre, while the yield to the city per inch will be $175 per year. This plan is to be submitted to the City Council and finally passed upon by the voters.——Announcement has been made of the incorporation of the California Delta Farms Co., with capital stock at $7,500,000 and $1100 subscribed. The land is situated near Stockton on the San Joaquin river. The work of development will be started soon. The chief organizer of the company is Lee A. Philipps, of the Mutual Pacific company. The directors are E. W. Maxson, W. E. Webb, H. J. Brown, A. W. Morgan, H. S. Dudley, C. H. Condee, R. D. Middleton, L. J. Marsh, W. N. Bucklin, E. L. Darrow, and G. C. Cook. The first meeting of the directors will be held soon.

Pasadena.—The Pasadena City Council, acting upon the recommendation of the Board of Water Commissioners, will make

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aplication to the city of Los Angeles for 500 miner's inches of Owens river aqueduct water.

Riverside.—Orval McReynolds, consulting engineer of Los Angeles, acting for the city, has proposed plans for saving the seepage from reservoirs No. 4 and 5 in the city water system. This loss aggregates $2,079,000 second-feet daily, or 30% of the quantity actually delivered to consumers. Mr. McReynolds has recommended that the city construct a tunnel 8000 ft. long through Mt. Baldy, open a channel to the portal of the tunnel, a distance of 1600 ft., and build a cut-off dam, at a total cost of $200,000, for the purpose of impounding the seepage from the two reservoirs and saving the loss of water. He recommends further that reservoir No. 4 be strengthened by creating an impervious face on the up-stream side of the dam and add sufficient material to the down-stream face of the dam. He also recommends that the city produce its own power for lighting and other purposes by utilizing the waste energy created by the fall of water down the mountain. F. F. Mallon is city engineer, and B. B. McReynolds is superintendent of water supply.

San Diego.—A syndicate composed of W. R. Hollingsworth, E. M. Fowler, J. E. Wagner, and Robert Marsh, all of Los Angeles, has acquired 10,000 acres of land in Linda Vista mesa. Water is to be developed for irrigation by artesian wells.

Stockton.—In a decision handed down by the Third District Court of Appeals in the case of the South Side Irrigation District *v.* W. B. Haroldson, it is said, in effect, that the directors of an irrigation district cannot force a land-owner to become a member against his will and assume a *pro rata* share of the assessment if the land is already irrigated by a private system. This decision affirms the judgment of the lower court, from which the case had been sent on appeal.

Klamath Falls, Oregon.—The city has voted to issue $785,000 in 6% bonds for the construction of the Horse-Fly Irrigation Project. This project will supply 20,000 acres of land with water, and actual construction work will commence in the early spring. Plans and specifications have already been drawn by the city engineer.

Spokane, Wash.—The gravity irrigation system for the Chelan orchard tract is nearly completed. The 14-mile flume for supplying water to 7000 acres of land is finished. A large force of men is employed in digging the high-line canal and in constructing two large dams, one at the outlet of Lake Antilon and the other at the outlet of Lake Wapato. These lakes will be utilized as storage reservoirs. Grant, Smith & Co. are contractors.

Grandview, Washington.—The City Council has let contract for the completion of the city water system to R. D. Gould, of Hood River, Oregon, for the sum of $12,750.

Petroleum

California oil dividends for October were as follows:

DIVIDENDS FOR OCTOBER

Amalgamated	$1.00	$ 50,000.00
American Pet., pfd	0.005	8,755.00
do common	0.00⅓	39,607.00
Caribou	0.00⅓	8,070.30
Central	0.0075	7,500.00
Claremont	0.01	5,000.00
Columbia	0.01	9,992.26
Fullerton	0.10	60,000.00
Home	0.01	5,000.00
Monte Cristo	0.025	12,500.00
Mount Diablo	0.015	7,500.00
New Pennsylvania	0.005	5,000.00
Olinda Land	0.0075	15,000.00
Pacific Crude	0.10	60,000.00
Paraffine	0.01	3,000.00
Record	0.01	5,000.00
Rice Ranch	0.015	4,500.00
S. F. & McKittrick	0.01	5,000.00
Sauer Dough	0.0075	2,992.50
Section Twenty-five	0.50	20,000.00
State Consolidated	0.01	5,000.00
Traders'	0.006	9,000.00
Union Oil	0.006	184,743.60
Union Provident	0.006	91,402.02
United Petroleum	0.006	48,450.60
W. K.	0.02	10,000.00
Western Union	0.005	5,000.00
Total Cal. companies		$668,113.28
Mexican Pet., pfd	0.20⅔	80,000.00
Grand total		$748,113.28

San Francisco.—The Maricopa, Ventura & Los Angeles Pipe Line Co. has been formed with an authorized capital stock of $5,000,000 to take over the holdings of the Guaranty Pipe Line Co. Mr. Cox, vice-president, does not anticipate any difficulty in making the exchange of stock.

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Production for all California fields for October was as follows:

OCTOBER PRODUCTION

	Gross bbl.	Fuel.
Coalinga	1,652,229	63,118
Kern River	1,056,037	175,000
McKittrick	592,862	28,217
Maricopa	510,127	45,826
Midway	2,561,862	72,507
Lost Hills	134,554	7,828
*Santa Maria	452,543	5,580
†Olinda	509,973	3,295
Salt Lake-Sherman	228,012	2,250
Whittier	64,482	2,675
Coyotes-La Habra	156,650	490
Los Angeles City	33,342	1,500
Summerland	4,950	600
Newhall	10,077	755
Ventura County	67,814	4,170
Totals	8,035,514	413,811

*Santa Maria, Lompoc, Cat Canyon.
†Olinda, Brea Canyon, Puente.

Field development for October was as follows:

	Prod. Ac.	Id.	Total.
Coalinga	847	206	1080
Kern River	1712	151	1976
McK.-Bel.	287	27	346
Maricopa	289	105	422
Midway	757	96	929
Lost Hills	42	...	48
*Santa Maria	233	44	287
†Olinda	328	17	347
Salt Lake-Sherman	285	13	301
Whittier	143	10	154
Coyotes-La Habra	11	...	13
Los Angeles City	412	...	412
Summerland	125	25	150
Newhall	78	5	83
Ventura county	303	28	336
Totals	5852	727	1247

*Santa Maria, Lompoc, Cat Canyon.
†Olinda, Brea Canyon, Puente.

Oil export statistics from three Pacific Coast districts for September were as follows:

Stocks on hand November 1 were as follows:

STOCKS

	Field.	Pipe-line.	Total.
Coalinga	338,405	2,652,720	2,991,125
Kern River	399,997	29,378,687	29,778,684
McK.-Bel.	122,200	761,215	883,415
Maricopa	372,360	280,314	652,674
Midway	562,390	1,713,689	2,276,079
Lost Hills	23,450	164,645	188,095
*Santa Maria	305,639	367,101	672,740
†Olinda	37,954	78,255	116,209
S. L.-Sherman	104,205	41,839	146,044
Whittier	30,726	.....	30,726
Coyotes-La H.	31,300	.....	31,300
‡Los Angeles	15,000	228,085	243,085
Newhall	5,775	.....	5,775
Ventura County	18,316	20,570	38,886
Outside	.....	8,911,591	8,911,591
Totals	2,367,717	44,598,711	46,966,428

*Santa Maria, Lompoc, Cat Canyon.
†Olinda, Brea Canyon, Puente.
‡Los Angeles City and District.

September's total exports of oil from twelve principal ports were 179,973,738 gal., valued at $12,013,690, as compared with 166,567,893 gal., $9,867,071, for September 1911. Of this amount, 26,040,119 gal., $819,809, were sent from the three districts of the Pacific Coast, namely, San Francisco, Puget Sound, and Arizona, the first's going to Spanish America and the Orient, the second's chiefly to Canada, and the third's wholly to Mexico. San Francisco's exports of residuum were 7,893,988 gal., $124,347, as against 6,972,043 gal., $233,994, for Sabine; 4,994,207 gal., $99,983, for Philadelphia, and 3,518,260 gal., $123,050, for New York. No crude was shipped from San Francisco, but Puget Sound exported 5,192,153 gal. of California crude to Canada, valued at $124,374, which, added to foreign shipments from San Francisco to Spanish America of fuel oil, makes a grand total for the month of 13,047,191 gal. (310,647 bbl.), valued at $245,853. The country's exports were distributed as follows: Crude, 16,434,125 gal., $656,723; illuminants, 106,328,645 gal., $6,660,083; lubricants and paraffin,

	Crude Fuel, Residuum.		Illuminants.		Lubricants.		Gasoline, Etc.	
	Gallons.	Value.	Gallons.	Value.	Gal.	Val.	Gal.	Val.
San Francisco	7,893,988	$124,347	10,895,946	$458,641	46,356	$11,089	12,493	$ 2,895
Puget Sound	5,586,939	149,481	5,329	966	16,857	4,857	50,165	9,314
Arizona	1,536,000	57,600	.....	.....	1,546	472	500	147
Totals	15,016,927	$331,428	10,901,275	$459,607	64,759	$16,418	63,158	$12,356

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16,298,604 gal., $2,088,107; naphthas, gasoline, etc., 15,100,889 gal., $1,952,334; residuum, etc., 25,811,475 gal., $656,443.

During August 1,813,656 gal. of all varieties of California oil were shipped to Hawaii, valued at $73,688. The features of the report for the first eight months of the year is the increase in the total shipments from 5,029,195 gal. over the same period of 1911, or from 35,224,921 gal., value $1,025,596, to 40,253,116 gal., value $1,232,495. In crude shipments there was a decline of 3,109,000 gal., $14,070. Total increase of shipments of fuel oil, crude, and residuum was 93,309.97 bbl., $86,288, or 785,149.53 bbl. to 878,459.52 bbl. the first eight months of 1912. The shipments of refined goods are also greatly increasing. Of illuminants, 553,329 gal. more were shipped than in the same time 1911; 82,634 gal. more of lubricants; of naphthas and gasoline, under which head comes a lot of light engine and stove distillates shipped from the Associated refinery at Gaviota, 473,193 gal. more. These figures are, moreover, a steady increase, not the result of abnormally low shipments in 1911, as the figures of that year show an almost equally large increase over those of 1910 in all lines of refined goods and about the same as to fuel oil.

The following table shows the first eight months of the respective years in detail.

Eight months, 1912:

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Crude	29,600,000	$ 634,180
Illuminants	1,620,989	162,492
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and $710,000 for the inner harbor will be provided by this issue. P. A. Haviland is county engineer.

Oakland.—It is probable that all work will be suspended for the winter on the construction of the new concrete arch bridge across Alameda creek near Niles on account of the slow progress made by the contractor.

Sacramento.—City engineer, A. Givan, will submit to the Department of Public Works data and plans for a sewer system for the annexed district. Gen. William H. Bixby, chief of the engineering corps, U. S. A., after inspecting Sacramento and San Joaquin river districts has generally approved of the proposed by-pass system as outlined in the April issue of *Western Engineering.*——The Ellicott Machine Co. expects to launch the hulls for the twin dredges now under construction for use in the flood control project for the Sacramento river within a few days. ——United States engineer in charge of the Sacramento and San Joaquin rivers is preparing to publish specifications for the construction of a gasoline tow-boat to act as tender for the dredges.

Los Angeles.—Special council to the Harbor Commission has approved the revised plans and specifications for the wharf along the west side of municipal dock number 1. The revised plans include the construction of a concrete wharf 2600 ft. long. Fourteen months will be allowed the contractor for completion. A storm-drain costing $8600 and a sanitary sewer costing $2250 will be built out of the harbor bond fund.——The Highway Commission has requested the Board of Supervisors to authorize the construction of a rock-crushing plant at the Pacoima rock-quarry. F. H. Joyner is chief highway engineer. The estimated cost of the plant is $2100.——Standard American Dredging Co. offers to dredge the channel east of municipal dock No. 1 for 20c. per cubic yard and filling at 15c. per cubic yard. ——The Harbor Commissioners and representatives of the San Pedro, Los Angeles & Salt Lake railroad have agreed upon the plan for widening the inner and outer harbor to a maximum and minimum breadth, respectively, of 950 and 750 ft. It is to be dredged to a uniform depth of 45 ft. The American Hawaiian Steamship Co. will build a concrete wharf 1000 ft. long and 100 ft. wide at San Pedro harbor, including a passenger and freight depot; $150,000 will be spent for these improvements. Bids for furnishing creosoted piling to be used in the construction of a 670-ft. wharf at the foot of Canal street, Wilmington, have been advertised for. Hermosa Beach has applied for permission to erect a pier at the foot of Santa Fe avenue to extend 1200 ft. from the high-water line. The Los Angeles Harbor Commission has prepared plans for a twin-screw gas-engine-operated fire tug to cost $20,000.

Berkeley.—The city council has voted in favor of calling an election to vote on the question of issuing bonds for the construction of new sewers and lighting plant and other municipal betterments. The sewer bond election is to be held the latter part of January and preliminary estimates will call for the expenditure of $180,000.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., of *Western Engineering*, published monthly at San Francisco, Cal., required by the Act of August 24, 1912.

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Business Manager:	
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JOHN J. YOUNG,	"
T. A. RICKARD,	London, E.C., Eng.
EDGAR RICKARD,	"

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L. A. GREENE.
(Signature of Bus. Mgr.)

Sworn to and subscribed before me this 4th day of October, 1912.

HENRY B. LISTER,
Notary Public.

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